NEW SERIES

SELECTED WATER RESOURCES ABSTRACTS

VOLUME 1, NUMBER 10B
OCTOBER 15, 1968

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Selected Water Resources Abstracts is published semimonthly for the Water Resources Scientific Information Center (WRSIC) by the Clearinghouse for Federal Scientific and Technical Information (CFSTI) of the Bureau of Standards, U. S. Department of Commerce. It is available to Federal agencies, contractors, or grantees in water resources upon request to: Manager, Water Resources Scientific Information Center, Office of Water Resources Research, U. S. Department of the Interior, Washington, D. C. 20240.

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SELECTED
WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center,
Office of Water Resources Research, U.S. Department of the Interior

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UNITED STATES DEPARTMENT OF THE INTERIOR
STEWART L. UDALL, Secretary

OFFICE OF WATER RESOURCES RESEARCH
Roland R. Renne, Director

WATER RESOURCES SCIENTIFIC INFORMATION CENTER
Raymond A. Jensen, Manager

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

A. General

HE HYDROLOGIC CYCLE AS A CLOSED YSTEM,
niversity College, Cork, Ireland.
ames C. I. Dooge.
ull of Int Ass of Sci Hydrol, Vol 13, No 1, pp 3068, Feb 1968. 11 p, 9 fig.

escriptors: *Hydrologic cycle, *Systems analysis, ydrology, Unit hydrographs, *Watersheds Basins), Groundwater, Storm runoff, Vadose ater, Soil moisture, Channels, Methodology, mulation analysis, Digital computers, Model stu- es, Surface-groundwater relationships.
lentifiers: *Systems hydrology, *Non-linear ethods, Parametric hydrology, *Threshold alues, Watershed characteristics, Predictions.

he essential nature of the systems approach to the ydrologic cycle is reviewed, and types of problems re classified. Textbooks represent the cycle ab- ractly with land surface and ocean surface as sin- e elements; local variation complexities are nored. In terms of moiture movement only, the ydrological cycle is a closed system; this is the ain concern of the hydrologist. In practice, the ydrologist confines his attention to individual asins; he leaves problems of the atmosphere to eteorologists, the lithosphere to the geologist, tc. These are sub-systems of the total cycle. The uthor describes 3 problems involving prediction, lentification, and simulation. He sees hydrologic ystems as a fruitful area for research, and suggests hat the next few yr will see rapid development of pecial non-linear theories tailored to fit special equirements.
V68-00319

HE INVESTIGATION OF RELATIONSHIP ETWEEN HYDROLOGIC TIME SERIES AND UNSPOT NUMBERS,
Universidad del Zulia, Maracaibo, Venezuela, and Colorado State University, Fort Collins.
gnacio Rodriguez-Iturbe, and Vujica Yevjevich.
olo State Univ Hydrology Pap No 26, 49 p, Apr 968. 18 fig, 3 tab, 20 ref, 7 append.

Descriptors: *Precipitation (Atmospheric), *Ru- off, Cloud physics, Condensation, Hydrologic cy- le, Weather, Weather data, *Weather patterns, Solar radiation, Correlation analysis, *Statistical ethods, Regression analysis, Variability.
dentifiers: *Sunspots, *Tree rings, Moving verages, *Time series, Residuals (Statistics), Coherence (Statistics).

The relationship of hydrologic series of monthly precipitation, annual precipitation, and annual ru- off to sunspot numbers was investigated by cross- orrelation analysis for various time lags (zero lag ncluded) and by cross-spectral analysis. 88 series f monthly precipitation and 173 series of annual precipitation (stations from western North Amer- ca), and 16 series of annual flows (stations from everal parts of the world) were used as research lata. No significant correlation was found between hese hydrologic series and sunspot numbers. In act, the spectrum of sunspot numbers proved to be nearly identical to the spectrum of residuals which vere obtained by deducting values of hydrologic eries from values of sunspot series. The coherence graphs worked out are within confidence limits of 2 ndependent time series, that indicate there is no elationship between hydrologic time series and unspot numbers. Sampling fluctuations of cross- correlation coefficients between hydrologic series nd sunspot numbers increase when both series are moothed by moving average schemes. Therefore, when the confidence limits of unsmoothed series are used in the smoothed series approach, incorrect conclusions may be drawn about the significance of correlation.
W68-00346

STUDYING THE INTERCONNECTION OF GROUND AND SURFACE WATERS IN REPRESENTATIVE BASINS UNDER THE PROGRAMME OF THE INTERNATIONAL HYDROLOGICAL DECADE,
All-Union Research Institute of Hydrogeology and Engineering Geology, Moscow, USSR.
I. S. Zektser, and S. M. Semenova.
Bull of Int Ass of Sci Hydrol, Vol 13, No 1, pp 25-28, Feb 1968. 4 p, 3 ref.

Descriptors: *Surface-groundwater relationships, Networks, Confined water, *Hydrogeology, *International Hydrological Decade, Stations, Hydraulics, Transmissivity, Lysimeters, Water table, Aquifers, Water balance, Aquicludes.
Identifiers: *Water interconnection, *Hydraulic connection, Riverside zone, Soviet Union, Pore water, Aquifer leakage, Confining beds.

Described is the role of Soviet Union hydrogeologists in solving problems in surface-groundwater relationships under the objectives of International Hydrological Decade. Major problems are the organization and completion of studies of groundwater flow to streams and study of surface-groundwater interconnection. Key network locations for evaluating the regional groundwater regime must be justified and techniques improved. Problems of groundwater artificial recharge and storage must be solved. Groundwater is least understood and is a chief task for study in solving total basin water balance. A method is given for estimating groundwater flow. Studies of groundwater flow and interconnection of ground and surface waters in the IHD representative basins are divided into 4 stages: (1) collecting and analyzing all available data on physical-geographical, hydrological, and hydrogeological conditions; (2) installing gages and observing streamflow for evaluating each discharging aquifer; (3) analyzing test and experiment results and determining types of hydraulic connection between ground and surface waters, and computing permeability of aquicludes and aquifer leakage; and (4) compiling groundwater flow maps, calculating the natural resources, and estimating role of groundwater in the basins.
W68-00546

DESIGN HYDROGRAPHS FOR PENNSYLVANIA WATERSHEDS,
Pennsylvania Department of Forests and Waters, Harrisburg, Pa.
John E. McSparran.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6036, pp 937-960, July 1968. 24 p, 12 fig, 6 tab, 16 ref, 2 append.

Descriptors: *Watersheds (Basins), *Hydrograph analysis, Runoff, Hydrology, Basins, Hydraulics, Pennsylvania, Rainfall, Geomorphology, Rainfall-runoff relatinoships, Mathematical models, Subsurface runoff, Unit hydrographs.
Identifiers: Drainage basins.

Physical and hydrologic characteristics of 26 Pennsylvania watersheds, ranging in size from 2.4 to 210 sq mi, were evaluated. Geomorphological characteristics and precipitation data help predict the unit hydrograph parameters through the regression equations; this leads to a unit hydrograph theory and ultimately a design hydrograph. The shape of the unit hydrograph can be expressed from small and medium watersheds by a mathematical expression which contains parameters that can be correlated to readily obtainable geomorphical basin characteristics. Interflow, a significant part of the total hydrograph is separated from surface runoff, and procedures are described to develop both. For surface runoff, readily obtainable watershed characteristics are correlated with parameters of a mathematical model for the unit hydrograph. Interflow is correlated with rainfall, runoff, and antecedent moisture conditions. A comparison of actual versus theoretical hydrographs from samll Pennsylvania watersheds showed this method yielded better results than either Snyder's synthetic unit graph method or the Soil Conservation Service's method.
W68-00559

HYDROLOGY AND WATER LAW: WHAT IS THEIR FUTURE COMMON GROUND,
Arthur Piper, and Harold E. Thomas.
In Water Resources and the Law, pp 7-24, 1958. Michigan Univ. Law School, Ann Arbor, 18 p, 12 ref (see W68-00581).

Descriptors: Hydrologic cycle, Hydrologic equation, Hydrologic aspects, *Water resources, *Hydrology, Water utilization, Competing uses, Prior appropriation, Long-term planning, *Water law, Water policy, Water users, Water rights, Riparian rights, Prescriptive rights, Natural flow doctrine, Reasonable use, Hydrogeology, Preferences (Water rights).
Identifiers: Eastern U. S., Western U. S.

Applied hydrology must accept two guides for the future: (1) inexpensive water, used, polluted and then returned is a thing of the past; (2) solution to supply shortages will require concerted action by large users making mutual concessions to the common advantage. The hydrologic cycle is compared to the classes of water established by the law, demonstrating that the interrelation within this cycle is generally not recognized by the law. Inconsistencies between the hydrologic equation and water law are pointed out. The hydrologic environments of the East and West are compared with the basic doctrines of water law prevalent in these areas. The riparian doctrine and the principles of reasonable use, correlative rights, and prescriptive rights--common to the East--are analyzed. The prior appropriation doctrine of the West is examined in relation to hydrologic principles. The authors conclude that trends in water management will eventually lead to obsolescence of the riparian doctrine, coupling of the appropriation doctrine to the police power to the end of optimum advantage to the public welfare, and management of surface and subsurface water as a single supply by a governmental agency of the utility type.
W68-00582

2B. Precipitation

THE FLORIDAN AQUIFER IN NORTHEAST FLORIDA,
Geological Survey, Water Resources Division, Jacksonville, Fla.
G. W. Leve.
Ground Water, Vol 6, No 2, pp 19-29, Mar-Apr 1968. 11 p, 8 fig, 1 tab, 9 ref.

Descriptors: *Groundwater, Florida, Water wells, Hydrologic data, *Aquifers, Water quality, *Water levels, Hydrogeology, Water table, Springs, Water level fluctuations, Water sources, Specific capacity, Hydrologic properties, Water yield, *Transmissivity, Leakage.
Identifiers: Jacksonville, Florida, Floridan aquifer, Water level measurements.

The Floridan aquifer was studied by the U.S. Geological Survey in cooperation with the Florida State Board of Conservation, the city of Jacksonville, and Duval County. It consists of limestone and dolomite of the Paleocene Cedar Keys Formation, the Eocene Oldsmar Limestone, Lake City Limestone, Avon Park Limestone and Ocala Group, the Oligocene Suwannee Limestone, and the Miocene Hawthorne Formation. The top of the Ocala Group ranges from 100 ft above sea level to 550 ft below. Water-bearing zones are separated by hard impermeable beds. Transmissivity ranges from 50,000 to over 1,000,000 gpd/ft. Storage ranges from .00015 to .017 in artesian areas. Recharge averages 500,000 mgd in the west and 45 in the south central part. Discharge occurs by springs and upward leakage in areas of artesian flow by wells in the east. Between 1940 and 1962, pressures declined 5 to 25 ft in the east. Seasonal declines at 5-10 ft in farm areas resulted in temporary increases of chloride of 200-500 ppm. Near Jacksonville chloride increased from 22 to 1,400 ppm in wells over 1,400 ft deep. Further contamination is likely unless remedial work is undertaken.
W68-00569

2C. Snow, Ice, AND Frost

SNOW ACCUMULATION STUDIES ON THE THULE PENINSULA, GREENLAND,
Army Cold Regions Research and Engineering Laboratory, Hanover, NH.
Steven J. Mock.
Army Material Command Cold Reg Res and Eng Lab Res Rep 238, 22 p, Feb 1968. 12 fig, 3 tab, 31 ref.

Descriptors: *Snow surveys, Statistics, Topography, Ice breakup, Isohyets, Snow cover, Slopes, Radar, Spatial distribution, Statistical methods, Temporal distribution, Moisture, Winds.
Identifiers: *Snow accumulation, *Greenland, *Ice wave, Ice flow, Stake measurements, Thule, Ice sheet.

Summary technical details are presented on the type and origin of wave features that break the ice sheet and cause changes in snow accumulation rates. Data are provided from stake measurements, marker boards, and pits along a 136-km trail crossing the Thule Peninsula. Regression analysis was used to predict mean annual accumulation; the analysis is consistent with observed results. The accumulation pattern over these features is predicted as a function of surface slope and regional elevation. Highest accumulation rates are associated with the topographically lowest parts of the features, and conversely. Mean annual accumulation is greater than 80 g/sq cm on the southern slope of the peninsula, but it decreases in direct proportion to increasing distance from Melville Bay and increasing elevation to less than 20 g/cm squared. Deviations (up to 15 g/sq cm) from regionally predicted accumulation values are related to localized topographic features, a series of waves or steps in particular. Profiles of surface and subsurface topography indicate a direct relationship between subsurface hills and steplike features, but cannot be quantitatively explained by existing ice flow theory.
W68-00352

US GEOLOGICAL SURVEY AND US NATIONAL PARK SERVICE GLACIER OBSERVATIONS, GLACIER NATIONAL PARK, MONTANA,
US Geological Survey.
A. Johnson.
U S Geol Surv open-file rep, 31 p, May 1968. 4 fig, 11 tab.

Descriptors: *Glaciers, Alpine, *Ablation, Melting, Melt water, *Movement, Regimen, Runoff, Snowmelt, Temperature, Stream gages, Discharge measurement, *Montana, Air temperature, Precipitation (Atmospheric), Data collections.
Identifiers: *Glacial profiles, Glacier National Park, *New method, Tapewriter, Climatic factors, Downglacier.

Data are presented from the 1966 and 1967 measurements of Grinnell and Sperry glaciers, Glacier National Park, Montana. They include surface elevation profiles, measurements of ablation stakes, delineation of termini, and measurement of movement by location of marked rocks and stakes. Annual precipitation and summer temperatures are measured near each glacier. Mean climatic data for the 30-yr period, 1931-1960, are included for the town of West Glacier. There are 2 gaging stations on Grinnell Creek, one operated only in the summer near the galcier, and an all yr gage below the outlet of Grinnell Lake. Profile and ablation measurements were not made in 1967.
W68-00360

DETERMINATION OF THE VOLUME OF SEASONAL ICE FORMATION IN RIVER BASINS BY THE HYDROCHEMICAL METHOD,
Russian Translation Board, Amer. Geophysical Union, Wash., DC.
N. G. Dimitriyeva.
Soviet Hydrol Selec Pap No 6, pp 578-601, 1966. 24 p, 4 fig, 10 tab, 40 ref, 5 append.

Descriptors: Discharge (Water), *Runoff, Snow, Snowmelt, Streamflow, *Surface-groundwater relationships, Water balance, *Runoff forecasting, Lake ice, Sea ice, Crystals, Freezing, Frozen ground, Melting, Ice-water interfaces, Water types, *Permafrost, Glaciers.
Identifiers: *Naleds, *Frozen streams, Streams-permafrost areas, USSR, Hydrochemical determination of ice formation, Siberia, Efflorescences.

A method is described for calculating the solid and liquid phases of dissolved solids in water during freezing, and the use of this method for determining the seasonal volume of ice in river basins in the permafrost zone is presented. The seasonal volume of ice consists of ice in the active permafrost layer, in swamps, in river channels, and in naleds. A 'naled' is a layer of ice formed on top of a frozen stream from ground water discharged from the stream's alluvium. The volume of ice is impossible to measure directly, so an indirect method was devised. If the dissolved content of a water source is constant, the concentration of salts in the unfrozen part of water will increase because ice freezes out of water in almost pure state. Therefore the amount of ice formed can be calculated if the temperature of ice in the frozen mass and the concentration of dissolved solids in the remaining runoff are known. The error of the method varies from 30-40% for a runoff of 100 mm to 5-10% for a runoff of 200 mm in the Kulu, Kolyma and Bureya rivers. The temperature used was the average of the Nov - Jan temperature and 0 deg C, the river temperature.
W68-00524

2D. Evaporation and Transpiration

WATER USE BY PLANTS,
Illinois Univ., Urbana, Ill.
D. S. Peters.
Plant Food Rev, Vol 14, No 1, pp 14-16, 1968. 3 p, 1 fig, 1 photo.

Descriptors: *Evaporation, Air-earth interfaces, Consumptive use, Water users, Fertility, Diffusion, Energy budget, Environmental effects, *Evapotranspiration, Soil water movement, Solar radiation, Transpiration, Plants.
Identifiers: Leaf area index, Root density, Relative evaporation, Radiation component, Latent heat demand.

Reviewed briefly are the processes of (1) consumptive use of water by plants and (2) evaporation from the land surface. Energy for moving water comes from the sun. The evaporation of water requires about 585 cal per gm. Water availability is often the most important factor in the amount evaporated. Other processes may compete for the required energy, and the ability of the air to transmit acquired moisture varies with humidity gradient and turbulence. Only radiant energy is independent. When water supply is limited, soil and plant factors have some control. The soil factor is the rate at which water can be transmitted to the surface; plant factors include root density, plant type, age, and leaf area. Total leaf area is probably the most important, because it increases both evaporation surface and energy-absorbing surface. Water-use efficiency increases with adequate fertility, so that increased crop yield is not proportional to transpiration. During the flowering and fruiting season root growth slows or ceases, reducing the absorbing surface for water and nutrients.
W68-00313

2E. Streamflow and Runoff

FREQUENCY CURVES,
US Geological Survey, Washington, DC.
H. C. Riggs.
US Geol Surv Tech Water-Resources Invest Book 4, chap A2, 15 p, 1968. 9 fig, 3 tab, 28 ref.

Descriptors: Streamflow, Hydraulics, *Frequency analysis, River flow, Distribution, *Distribution patterns, *Statistical methods, Duration curves, *Analytical techniques, Correlation analysis, Surface waters, Hydrologic data, Mathematical studies, Flow characteristics, Sequence, Distribution, Frequency, Mathematical methods.
Identifiers: *Cumulative distribution, Extreme-value distribution, Flow analysis, Normal distribution, *Graphical analysis.

Graphical and mathematical procedures for preparing frequency curves from hydrologic data are described. The theory and correct interpretations of frequency curves are discussed also. The advantages of graphical and mathematical fitting are compared, and methods are suggested for describing graphically defined frequency curves analytically. Distributions used in hydrology that are discussed in the manual are normal, lognormal, Type I extreme-value (Gumbel), Type II extreme-value, Pearson Type III, and graphically defined distributions. Mathematical curve fitting discussed includes normal, 3-parameter, Type I and Type III extreme-value distributions.
W68-00321

WATER BALANCE AND FLOW UNDER MANTLED KARST CONDITIONS,
Russian Translation Board, Amer. Geophysical Union, Wash., DC.
O. L. Markova.
Soviet Hydrol Selec Pap 106, pp 568-578, 1966. 11 p, 2 fig, 9 tab, 19 ref.

Descriptors: *Karst, Carbonate rocks, Caves, *Drainage effects, *Groundwater, Runoff, *Sinks, *Subsurface drainage, Underground streams, Stream gages, Evaporation, *Water balance.
Identifiers: *USSR, Surface-underground drainage relations, *Mean annual runoff, Aquifer-stream relationships.

A quantitative estimate was made of the influence of karst conditions on river runoff to learn how such conditions alter the relative amounts of runoff and evaporation in karst streams in comparison to nonkarst streams in the southern Urals and in Italy. The estimate was made by the water balance method and the comparison method. The water balance method depends on calculation of precipitation and evaporation which cannot presently be done accurately. The comparison method consists of comparing runoff of karst rivers with the values of runoff for the climatic zone. Runoff in 50 karst rivers compared to 50 nonkarst rivers was close to normal zonal runoff or 10 to 20% lower. The main influence of karst on water balance is the noncoincidence of river basin catchment and karst recharge area, an effect which increases with decreasing catchment area. Basins under 500 sq km may have rivers with discharge several times smaller or larger than normal zonal runoff. The effect of altered evaporation rate seems to be negligible.
W68-00519

COMPUTER SIMULATION OF UNSTEADY FLOWS IN WATERWAYS,
Geological Survey, Washington, DC.
Robert A. Baltzer, and Chintu Lai.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6048, pp 1083-1117, July 1968. 35 p, 25 fig, 2 tab, 1 append.

Descriptors: *Computer models, *Flow characteristics, Estuaries, Rivers, Numerical analysis, Unsteady flow, Hydraulics, Mathematical models, Digital computers, Channel morphology, Fluid friction, Flood routing, *Analytical techniques, Channels, Hydrodynamics.
Identifiers: *Digital computer simulation, Partial differential equations, Waterways, Flow simulation, *Transient flows, Simulation.

The hydrodynamics of transient flows in rivers and stuaries, and prediction techniques for such flows re considered. A mathematical model to develop distinctly different techniques for digital simulaion of unsteady flows utilizes nonlinear, partial differential equations to describe one-dimensional, ranslatory wave motion. The first simulation echnique is based on power series methods and ses a Maclaurin series expansion of the governing artial differential equations. The second echnique uses a numerical evaluation process at uccessive specified time intervals. The third echnique relies upon an implicit method of flow imulation wherein the partial differential equaons are transformed to finite difference equations. The effects of fluid friction, variable channel eometry, wind, lateral inflow or outflow, the Coriolis acceleration, and overbank storage are included. Flows are considered to be of homogeneus density. Good agreement was found between imulated flows obtained from each of the simulaion techniques when compared with the appropriate field measured transient flows.
W68-00552

WHAT IS DROUGHT,
Geological Survey, Menlo Park, Calif.
Walter Hoffman, and S. E. Rantz.
Journal of Soil and Water Conserv, Vol 23, No 3, pp 105-106, May-June 1968. 2 p, 10 ref.

Descriptors: *Droughts, Water shortage, Precipitation (Atmospheric), Water loss, Streamflow, Soil moisture, Agriculture, Crops, Fluctuation.
Identifiers: Moisture deficit, *Definition, Hydrologic drought, Agricultural drought, Palmer drought index.

There is no precise, universally acceptable definition for 'drought'; it is usually described in relative terms. Criteria used in definitions may include one or more parameters of: precipitation, streamflow, groundwater levels, soil-moisture conditions, crop yield, or economic hardship, in relation to deviation from the norm. Hydrologic drought is usually thought of as deficiency in precipitation or runoff, and groundwater level decline over a long period of time. The U.S. Weather Bureau uses the Palmer drought index to classify drought severity. Agriculturists usually define drought in terms of soil-moisture deficiencies relating to crop yield. Drought is a 'non-event' or situation, as opposed to a distinct event, such as a flood. The drought terminates when interrupted by a short wet period. It is concluded that there is no quantitative definition of drought that is universally acceptable.
W68-00555

THE RELATIVE CONTRIBUTION OF PARTICULATE CHLOROPHYLL AND RIVER TRIPTON TO THE EXTINCTION OF LIGHT OFF THE COAST OF OREGON,
Oregon State University, Department of Oceanography, Corvallis, Oreg.
Lawrence F. Small, and Herbert Curl, Jr.
Limnol and Oceanogr, Vol 13, No 1, pp 84-91, Jan 1968. 8 p, 5 fig, 10 ref.

Descriptors: *Light penetration, *Chlorophyll, *Tripton, *Oregon, Aquatic drift, Organic matter, Coasts, Streamflow, River flow, Water analysis, Turbidity, Water temperature, Tidal effects, Discharge (Water).
Identifiers: *Extinction coefficient, Upwelling, Inorganic suspended matter, Coastal mixing, River mouth.

Extinction coefficients and chlorophyll-a concentrations were measured for 3 years along sampling lines off the mouth of a large and a small river, and a section of Oregon coastline with little river outflow. The relative contribution of particulate chlorophyll and nonliving suspended matter (tripton) to the extinction coefficient, k, was assessed mathematically. The effect of river discharge into the sea is twofold: to increase tripton turbidity, and thus k, and to change the oceanic relationship between chlorophyll-a concentration and k in areas subject to, but not overwhelmed by, river discharge. The first effect is more pronounced with large volumes of discharge and becomes less significant with increasing distances from the river mouth. Beyond the areas marked by tripton turbidity, k apparently is a function of chlorophyll concentration only in winter and spring when river discharge is low. In areas that never receive significant river discharge, k is a function of chlorophyll concentration during all seasons except possible summer, when upwelling may at times destroy the relationship.
W68-00574

OPERATIONAL HYDROLOGY USING RESIDUALS,
Federal Water Pollution Control Administration, Division of Technical Control, Washington, DC.
George K. Young, and William C. Pisano.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6034, pp 909-923, July 1968. 15 p, 2 fig, 6 tab, 5 ref, 2 append.

Descriptors: *Hydraulics, Hydrology, Markov processes, River basins, Streamflow, Simulation analysis, River basin development, Correlation analysis, Gaging stations, Statistical models, *Water quality.
Identifiers: *Operational hydrology, Matrix algebra, Fortran IV, *Residuals, Hieterical records, Simulated statistics.

An algorithm for simulating multisite streamflow or water quality data for hydrologic management and planning studies is demonstrated. The technique for generating synthetic hydrologic data is simple in concept but has wide applicability. It is easily calculated by using a FORTRAN IV program, and can be understood in the light of matrix algebra techniques. The principal concepts involved are: (a) straightforward consideration of cross-linkage and Markovian correlations between gaging sites, and (b) use of time-independent residual data having low average skewness for parameter estimation. Conclusions are: (1) The scheme preserves means, standard deviations, cross correlations, and an underlying Markov structure in the residuals; (2) Input data must have values for each cell, but data having missing values can be filled in by using techniques described in literature; (3) Water quality as well as water quantity can be simulated.
W68-00575

FLOW AROUND 180 DEGREES BENDS IN OPEN RECTANGULAR CHANNELS,
Washington State University, College of Engineering Research Division, Pullman, Wash.
Mostafa M. Soliman, and E. Roy Tinney.
ASCE Proc, J of Hydraul Div, Vol 94, Pap 6027, pp 893-908, July 1968. 16 p, 14 fig, 1 tab, 8 ref, 2 append.

Descriptors: *Open channel flow, Head loss, Hydraulic jump, Kinetics, Banks, Hydraulics, Hydrodynamics, Energy dissipation, Eddies, Testing, Channels, Velocity, Friction, Froude number, Flumes, Vortices, Flow separation.
Identifiers: *Flow pattern, Channel bends, *Energy loss, Secondary currents, Bend geometry.

A theoretical analysis of head losses in 180-deg open channel bends is developed based on the moment of momentum and continuity principles. Experimental data under varying flow conditions and differing bend geometries are analyzed to check the theory. Circular arc vanes are used to change the bend geometry so that flow lines remain parallel to boundaries and minimize total head losses; the vanes reduced the losses by 67%. A hydraulic jump will occur downstream from the bend if the K value becomes large with respect to the Froude number.
W68-00576

2F. Groundwater

WATER RESOURCES OF POINTEE COUPEE PARISH, LOUISIANA,
US Geological Survey.
M. D. Winner, Jr., M. J. Forbes, Jr., and W. L. Broussard.
Louisiana Geol Surv and Dep of Public Works Water Resources Bull No 11, 110 p, Mar 1968. 25 fig, 11 plate, 5 tab, 44 ref.

Descriptors: *Aquifer characteristics, Water resources developments, *Hydrologic aspects, Aquifers, *Appraisals, Surface waters, Water quality, Brackish water, Desalination, Environmental effects, Lakes, Recreation, Pollutants, Coliforms, Rivers, Use rates, Water management (Applied), *Louisiana.
Identifiers: *Water availability, Environmental controls, Untapped sources, Water transportation, Recreational uses, Aquifer evaluations.

The quantity, quality, and availability of water for public, industrial, agricultural, and domestic uses is appraised. Existing or potential water problems are cited, and solutions are suggested. Fresh water occurs in sand beds to depth of 2,600 ft below sea level in the southern part; as many as 12 aquifers are present in some places. Large-diameter wells yield 1,000-2,000 gpm in typical thick aquifers and more in the coarser-grained alluvial aquifer. The water ranges from hard, calcium bicarbonate type in alluvium to soft, sodium bicarbonate in deeper sands. Wells furnish 90% of the 3.5 mgd of water used, most of it from the alluvium for irrigation and industry. Except for transportation and recreational purposes, only 0.5 mgd of the vast surface-water supply is used. Conclusions are: (1) Abundant quantities of fresh groundwater and almost unlimited supplies of surface water are available for development; (2) large reserve of saline groundwater, ranging from slightly brackish to concentrated brines, is a future resource to potential users of saline water for desalination, industrial cooling or other needs; (3) water-quality problems can be overcome by sound management based upon available data; and (4) vast water-supply potential is an asset for economic growths in the parish.
W68-00316

GROUND-WATER RESOURCES OF TYLER COUNTY, TEXAS,
US Geological Survey.
George R. Tarver.
Tex Water Develop Board Rep 74, 91 p, May 1968. 16 fig, 5 tab, 22 ref.

Descriptors: *Aquifer characteristics, *Hydrogeology, Appraisals, Hydrologic aspects, Geologic control, *Texas, Underground storage, Transmissivity, Physical properties, Water quality, Saline water, Pump testing, Water resources development, Withdrawal, Standards, Water levels, Temperature, Springs.
Identifiers: *Aquifer evaluations, *Potential water supply, Well logs, Isochlor maps, Geologic sections, Untapped sources.

Details are presented of the availability, dependability, quality, and quantity of groundwater suitable for municipal, industrial and irrigation needs in this 918-sq-mi area in eastern Texas. Hydrologic and geologic units and their hydraulic characteristics are described. Data tables are given of wells, chemical analyses of aquifer waters, transmissivity tests, and driller's logs; 16 maps, graphs, and geologic sections illustrate the report. At present the aquifers beneath Tyler County are largely untapped. Total withdrawals of 2.3 mgd (1964) compare with 62 mgd that is transmitted by the 3 major aquifers (Jasper, Evangeline, and Chicot) under present hydraulic gradient of 5 ft/mi. The 3 aquifers contain 80 million acre-ft of water in storage, of which 23 million is within 400 ft of land surface. The county's southern half has the greatest potential for water-supply development. Groundwater in the principal aquifers is suitable for most

purposes; it is a sodium or calcium bicarbonate type, low in dissolved solids, chloride, and sulfate.
W68-00318

A HYDROGEOLOGIC STUDY OF THE GROUND-WATER RESERVOIRS CONTRIBUTING BASE RUNOFF TO FOUR MILE CREEK, EAST-CENTRAL IOWA,
US Geological Survey.
George R. Kunkle.
US Geol Surv Water-Supply Pap 1839-0, pp 01-041, 1968. 41 p, 16 fig, 1 plate, 1 tab, 18 ref.

Descriptors: *Base flow, Evapotranspiration, Groundwater recharge, Hydrologic budget, Hydrologic properties, Hydrogeology, Leakage, Iowa, Regional analysis, Bank storage, Glacial drift, *Discharge (Water), Loess, *Streamflow, Geology, *Surface-groundwater relationships, Groundwater.
Identifiers: Groundwater outflow, Hydrologic properties (Methods), Groundwater system, Alluvial aquifer, Diurnal fluctuations.

Paper describes how aquifers control the base flow of a stream in a 20 sq mi basin in east-central Iowa. There are 2 interconnected aquifers, upland loess and bottom-land alluvial sand. The loess is a watertable aquifer which drains to tributary streams of the alluvial aquifer. The alluvial aquifer is semiartesian, about 15 ft thick, and drains to Four Mile Creek. Leakage to the underlying till is from both aquifers and averages 1.8 in./yr. A table gives the hydrologic budget for each aquifer for 1963-64. Recharge to the loess averaged 2.1 in/yr and discharge to base flow was 0.2 in. The loess contributed up to 33% of the total base flow in the fall and winter but none in summer. Recharge to the alluvial-sand aquifer was about 3.2 in/yr, mostly from precipitation and bank-storage inflow. The sand discharges about 1.4 in/yr to base flow, about 40% of which is through bank-storage outflow. Maps at 1:20,000 scale show topography and isopachs of the alluvial sand and confining clay. Methods are described for determining hydrologic properties of the alluvial sand and for obtaining evapotranspiration loess and bank-storage component of outflow.
W68-00327

SOLUTION OF AN UNUSUAL SUBSURFACE DRAINAGE PROBLEM,
Nottingham Univ., Department of Civil Engineering, Nottingham, England.
Edward William Brand.
ASCE Proc, J of Irrig and Drainage, Vol 94, No IR2, Pap 5973, pp 199-221, June 1968. 23 p, 11 fig, 2 tab, 2 ref, 2 append.

Descriptors: *Drainage, *Groundwater, *Civil engineering, Highways, Wells, Drainage wells, *Drainage engineering, *Subsurface drainage, Iron oxides, Water table, *Drawdown, Subsurface drainage, Iron oxides, Water table, *Drawdown, Subsurface waters, Drainage systems, Seepage, Road construction, Hydraulic conduits, Underground structures, Foreign countries.
Identifiers: *Highway construction, *Iron precipitation, Horizontal wells, Collection galleries, Water table lowering, Ferric oxide.

Details are given of all stages in the design of a subsurface drainage system for the inner ring road at Antwerp, Belgium. Because of the high water table and low longitudinal profile of the road, a continuous drawdown facility was devised. Pumping tests indicated a coefficient of permeability of .00007 m/sec and seepage of 1 cu m/sec as a result of lowering the water table. The drainage system designed would consist of perforated pipe placed in longitudinal collecting galleries at the extremes of the road cross section. Manholes at 40-m intervals would act as water-table control points, and would enable the collected water to enter a pipe and be carried to 2 pump stations. These stations would also remove storm runoff. Chemical analysis indicated the groundwater had an iron content of 12 mg/l. Because a voluminous ferric oxide/water precipitate results from contact of the water with air, elaborate precautions were taken to keep the perforated intake pipes and gravel-filled collection galleries submerged at all times.
W68-00328

THERMAL WATERS OF SIBERIAN PLATFORM AND ITS FOLDED-MOUNTAINS FRAMING,
I. S. Lomonosov, and S. V. Lysak.
Int Geol Rev, Vol 10, No 1, pp 13-22, Jan 1968. 10 p, 3 fig, 3 tab, 8 ref.

Descriptors: *Hydrogeology, *Artesian wells, Springs, Hot springs, *Thermal springs, Saline water, Wells, Geothermal studies, Permafrost, Confined water, Groundwater basins, Temperature, *Thermal water.
Identifiers: *Siberia, Siberian Platform, Mineralization, Water prospecting, Basement rocks.

The geothermal conditions of the platform artesian basins on folded provinces in eastern Siberia are described, and the data, reviewed. Depths of wells, depth of basement, and temperatures are tabulated, and thermographs, constructed. The geothermal gradient is lowest--1-1.15 deg per m--in carbonate-saline deposits of the Lower Cambrian; it is 2-2.5 deg per m in Ordovician and Cambrian deposits of argillaceous, sandy and anhydritic rocks. In the Angara-Lena artesian basin the basement temperature varies from 20 to 135 deg, with the higher temperatures at greater depths. The thermal artesian waters are chloride brines. The Angara-Lena basin discharges sodic brines, related to zones at tectonic disturbance. The central part of the basin has calcic brines, and in the rest of the region, waters are mixed sodic-calcic. Dissolved gases are nitrogen, methane, and hydrogen sulfide. Wells rarely yield over 1 liter per sec, and the temperature of water at the point of discharge is usually 10-15 deg. Low yields limit the usefulness of the wells. The most promising region for prospecting is the Vilyvy depression and the Priverkhoyanskiy downwarp. Thermal springs are useful for medicinal purposes at several resorts, and for heat in eastern Siberia where the climate is hard.
W68-00339

SOLVING THE PROBLEM OF LOCAL INTERFACE UPCONING IN A COASTAL AQUIFER BY THE METHOD OF SMALL PERTURBATIONS,
Technion-Israel Institute of Technology, Haifa, Israel.
G. Dagan, and J. Bear.
J of Hydraul Res, Vol 6, No 1, pp 15-44, 1968. 30 p, 11 fig, 11 ref.

Descriptors: *Hydraulics, Darcys law, *Equations, *Groundwater, Hydraulic gradient, *Saline water-freshwater interfaces, *Boundary processes, *Saline water intrusion, Shallow wells, Potentiometric level, Steady flow, Aquifers.
Identifiers: *Boundary conditions, *Method of small perturbations, *Coastal aquifer, *Israel, Physical models.

A mathematical method was derived and experimentally verified to predict movement of the salt-water freshwater interface near Israel's coastal collector, an array of shallow wells to intercept seaward-flowing fresh water. Darcy's law was expanded into exact expressions for solving the problem of a moving interface in 3 dimensions. Because the boundary conditions are nonlinear and are, in fact, part of the problem, a linear approximation based on the method of small perturbations was used as a tool to solve small deviations of the interface from the steady-state position. Both 2 and 3 dimensional cases were considered. The analytical method was checked by construction of an experimental flow box filled with crushed glass of known porosity and permeability. Movement of an initially steady interface was determined under both 2 dimensional and axially symmetric flow conditions. The range of validity of the approximate solutions was up to 1/3 the initial distance between interface and sink, for both 2 and 3 dimensional flows.
W68-00358

DIFFUSION OF ENTRAPPED GAS FROM POROUS MEDIA,
Colorado State University, Fort Collins, Colo.
K. M. Adam, and A. T. Corey.
Colo State Univ Hydrol Pap No 27, 43 p, Apr 1968. 26 fig, 6 tab, 26 ref, 3 append.

Descriptors: *Diffusion, *Porous media, Diffusivity, *Equations, Interfaces, *Air-water interfaces, Wettability, Solubility, Boundary processes, *Bubbles, Pressure, Unsaturated flow, Surface tension, Pores, Solubility.
Identifiers: *Graphical extrapolation, Normalized curves, Saturation fronts, Wetting fluids, Nonwetting fluids, Entrapped gas, Pore size.

Experiments were made to test equations that describe gas diffusion from isolated pockets in a porous medium being invaded by a liquid. Both earlier equations by Bloomsburg and new work were tested, neither of which adequately describes the process. The experimental data may best be used for prediction by graphical extrapolation, which gives both the time at which full liquid saturation would occur and the distribution of the liquid at any time. The normalized curves relate air content to dimensionless length and dimensionless time. A zone of complete saturation forms at the exterior face and moves toward the interior of the sample, but no theory which assumes that diffusion occurs only at the saturation front is adequate to describe the diffusion process. The rate of diffusion is greatest in materials with high bubbling pressures or which are fine-grained. The amount of gas entrapped is affected by ambient pressure at the time of initial imbibition, and it is changed by any change of ambient pressure throughout the process.
W68-00361

HYDROLOGICAL STUDY OF THE LATTON GROUND-WATER SOURCE,
Swindon Corporation Water Department, Civic Offices, Swindon, Wilts, England.
A. R. Burton.
J of Inst of Water Eng, Vol 22, No 4, pp 287-293, June 1968. 7 p, 2 fig.

Descriptors: *Hydrologic aspects, *Mathematical models, Aquifers, Drill holes, Aquifer characteristics, Appraisals, Springs, Specific yield, Recharge, Infiltration, Rainfall, Water levels, Permeability, Dewatering, Groundwater basins, Limestones, Water management (Applied).
Identifiers: *Hydrological evaluation, *Latton, England, Boreholes, Isopiestic map, *Aquifer model, Water availability.

Relationships between different parameters in groundwater hydrology are demonstrated, and estimates of volume and reliability of yield of the Latton watersupply source are made. A mathematical model is postulated, using influence coefficients for flow rate, discharge, and recharge quantities for prediction of water levels in aquifers. Data consist of water levels, rainfall, and abstraction. Percolation and recharge are discussed, an aquifer model is described, and magnitude and reliability of yield are estimated. The conclusions reached are: (1) Records of rainfall, abstraction, and groundwater levels are interrelated; and (2) a mathematical model can be set up to predict water levels within the radius of influence. Yield is assessed at an average of 5.5 mgd. The concept of influence coefficients used in the mathematical model can also be used for estimating various aquifer properties.
W68-00538

RESULTS OF 10 YEARS OF OBSERVATION ON THE WATER TEMPERATURE OF SPRINGS IN THE VICINITY OF MOSCOW,
Russian Translations Board Amer. Geophysical Union, Wash., DC.
V. V. Piotrovich.
Soviet Hydrol Selec Pap No 6, pp 602-634, 1966. 33 p, 7 fig, 12 tab, 3 ref.

Descriptors: *Springs, Groundwater movement, Hydrogeology, Air temperature, Soil temperature, Water temperature, Erosion, Discharge (Water), Thermal water, Thawing, Landslides, Sands, Gravels, Groundwater basins.
Identifiers: *Spring water temperature, USSR, Moscow.

The results of 10 years of observation twice a month of the water temperature of springs in the vicinity of Moscow are reported. Some springs are described; the annual and long-term temperature patterns are given, and factors governing water temperature are indicated. Detailed temperature data are given in an appendix. The areas studied were the bank of the Khimki River, with 8 springs, the Lenin Hills near the Moskva River, with 10 springs, and a spring at Krasnaya Presnya. The springs discharge from 0.1 to 3.0 liter per sec each from an aquifer above the Jurassic. Spring water temperatures fluctuate much more widely (1.2-6.3 deg C) than groundwater temperatures, which vary only 0.2-0.3 deg C. This is because the waters in spring channels are flowing in contact with surficial materials with highly variable temperature. Daily variation is small because daily temperature changes extended only 1 m into soil, but prolonged hot and cold periods longer than 10 days may affect soil temperatures as much as 3 m deep and have a correspondingly greater effect on spring temperature. Temperatures and variation of temperature are not the same at neighboring springs because of variable soil temperature regime due to slope exposure and urban development.
W68-00551

GEOHYDROLOGY: RECENT PROGRESS,
Geological Survey.
Raymond L. Nace.
Geotimes, Vol 13, No 4, p 16, Apr 1968. 1 p.

Descriptors: *Hydrogeology, *Systems analysis, Percolation, Darcys law, Vadose water, Hydraulic gradient, Infiltration, Osmotic pressure, Electrochemistry, Geophysics, Model studies, Remote sensing, Resource development, Radioisotopes, Tracers, Radioactive dating, Injection wells, Radioactive wastes.
Identifiers: *Geohydrology, Photohydrology, Geophysical techniques, Resource management, Hydrological systems.

Research on total systems is stressed, with special attention to processes of recharge of groundwater, and movement within aquifers. A brief summary is given of recent progress and trends. Among topics covered are the following: the mechanics of percolation and infiltration; the applicability of Darcy's law to flow of water in various sediments; the relation of Darcy's law to osmotic pressure, to electrochemical and thermal gradients, and to the analysis of pumping tests; the use of geophysical logging with special application to 3-dimensional modelling of aquifer systems in analogs and computers; the development of remote sensing for synoptic mapping; the applications of infrared and conventional photography in the new field of photohydrology; unified water management; the use of radionuclides as water tracers; the use of naturally dispersed nuclides (such as tritium) in studies of air mass movements and water vapor sources; carbon-14 dating of groundwater, and use of air and gas injections underground to block saline water migration and to provide delayed storage of radioactive waste gases.
W68-00554

SAFE YIELD OF A WELL FIELD IN A LEAKY-ARTESIAN STRIP AQUIFER,
Research Council of Alberta, Groundwater Division, Edmonton, Alberta, Canada.
A. Vanden Berg, and D. H. Lennox.
Ground Water, Vol 6, No 2, pp 30-36, Mar-Apr 1968. 7 p, 8 fig, 4 tab, 12 ref, 1 append.

Descriptors: *Safe yeild, *Aquifers, Groundwater, Hydrologic equation, Pumping, Rates, Water yield, Withdrawal, Artesian wells, Confined water, *Water wells, Mathematical studies, *Theis equation.
Identifiers: Well interference, Interference drawdown, Canada, Leaky artesian aquifer theory, Jacob equation, Alberta, Canada.

The basic formulas required for safe yield estimation for an array of n wells located in the axis of an infinite-strip leaky-artesian aquifer are developed. Test results can be analyzed and future drawdowns predicted by applying the standard leaky-artesian formula in conjunction with image-well theory, making allowance for well-loss factors. A linear equation will apply for any well if flow near the well always obeys Darcy's law for all pumping rates of interest. If all n required equations are linear, they may be solved by matrix algebra; if not, trial and error must be used. The method is illustrated by application to a 6-mile stretch of a buried-valley aquifer near Edson, Alberta. The numerical coefficients in the system of equations are first derived and the equations then solved to obtain estimated safe yields for well arrays of up to 38 evenly spaced wells.
W68-00560

TECHNIQUES FOR COMPUTING RATE AND VOLUME OF STREAM DEPLETION BY WELLS,
Geological Survey, Denver, Colo.
C. T. Jenkins.
Ground Water, Vol 6, No 2, pp 37-46, Mar-Apr 1968. 10 p, 5 fig, 3 tab, 10 ref, 1 append.

Descriptors: *Surface-groundwater relationships, Groundwater, Hydrologic equation, *Streamflow, Surface waters, *Mathematical models, Analog models, Hydrologic data, Analytical techniques, Colorado.
Identifiers: Error functions, Line source integrals, Streamwater loss to wells.

The effects on flow of a nearby stream from pumping a well can be calculated readily using dimensionless curves and tables. Computations can be made of: (1) the rate of stream depletion at any time during the pumping period or after the cessation of pumping; (2) the volume induced from the stream at any time, both during pumping or after the cessation of pumping; and (3) the effects, both in rate and volume of stream depletion, of any selected pattern of intermittent pumping. Sample computations illustrate the use of the curves and tables. An example shows that intermittent pumping may have a pattern of stream depletion not greatly different from a pattern for steady pumping of an equal volume. The residual effects of pumping, that is, effects after cessation of pumping, on streamflow may easily be greater than the effects during the pumping period. Adequate advance planning that includes consideration of residual effects thus is essential to effective administration of a stream-aquifer system. Paper includes definitions, 4 solved problems, and 5 curves for solving field problems.
W68-00567

ANALYSING PUMPING TESTS BY RESISTANCE NETWORK ANALOGUE,
Birmingham University, Civil Engineering Department, Birmingham, England.
Robin Herbert.
Ground Water, Vol 6, No 2, pp 12-18, Mar-Apr 1968. 7 p, 10 fig, 1 tab, 8 ref.

Descriptors: *Analog computers, *Analog models, Computer models, Specific capacity, Discharge (Water), Drawdown, Pumping, Water wells, Aquifers, Observation wells, Storage coefficient, Water levels, Water table, *Resistance networks.
Identifiers: *Pumping test analysis, Resistance network analog models, Time-drawdown curves.

A resistance network analogue is used to study the early stages of a pumping test in an unconfined aquifer. The results are compared with an alternative analysis due to Boulton (1965), and a good agreement is obtained. Time drawdown curves can be developed at any radius, and rise and fall of the water table near a pumped well may be plotted. Discharge rates associated with any water table position may be determined. The results are valid only for rigid unconfined aquifers in which the water is given up from storage instantly. Unlike the theoretical analysis the analogue technique is versatile and can easily be used to study pumping tests with nonidealized boundary conditions, e.g. partially penetrating wells can be simulated. Thus the analogue method of analysis could prove to be a more realistic method for studying pumping tests than standard analytical techniques.
W68-00571

2G. Water in Soils

FACTORS INFLUENCING HYDRAULIC CONDUCTIVITY OF SOILS IN THE PRESENCE OF MIXED-SALT SOLUTIONS,
Agricultural Research Service, US Department of Agriculture, Riverside, Calif.
B. L. McNeal, D. A. Layfield, and W. A. Norvell.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 187-190, Mar-Apr 1968. 4 p, 3 fig, 4 tab, 9 ref.

Descriptors: *Hydraulic conductivity, Permeability, *Ion exchange, *Iron oxides, Magnesium, Expansive clays, Leaching, Soil chemistry, Clays, Porosity, *Saline water, Soil water, Soil texture, Soil stabilization, Soil water movement, Organic soils.
Identifiers: *Salt-affected soils, Sodic soils, Sodium absorption ratio, Extractable constituents, Mixed-salt solutions.

Permeameter testing was conducted on a group of soils having variable clay content but nearly uniform clay-fraction mineralogy. Results showed that relative hydraulic conductivity in the presence of mixed-salt solutions decreased markedly with increasing clay content, particularly at the lowest salt concentrations employed. The stability of a group of Hawaiian soils under high-sodium, low-salt conditions was greatly reduced by partial removal of the free iron-oxides. Replacing the Ca in percolating NaCl-CaCl sub 2 solutions with Mg measurably decreased soil hydraulic conductivity, although the effect was often negligible when comparisons were made at equivalent exchangeable-sodium-percentages.
W68-00324

BULK VOLUME AND HYDRAULIC CONDUCTIVITY CHANGES DURING SODIUM SATURATION TESTS,
California Univ., Berkeley, Calif.
L. J. Waldron, and G. K. Constantin.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 175-179, Mar-Apr 1968. 5 p, 3 fig, 2 tab, 13 ref.

Descriptors: *Soils, *Soil aggregates, Soil structure, Wettability, Soil stability, *Soil chemistry, Expansive clays, *Ion exchange, Soil water, Leaching, Pore pressure, Porosity, Permeability, Hydraulic conductivity, Saline water.
Identifiers: Pore size distribution, Bulk volume changes, Axial stress, Salt-affected soils, Aggregate failure, Swelling pressure.

Fragmented samples of 1 organic and 5 mineral California soils were permeated with salt solutions while confined in cylinders under a constant axial stress of 0.05 bar. Continuous and precise measurement of bulk volume changes during sodium saturation with 1M NaCl followed by 0.25M NaCl

showed that while hydraulic conductivity always decreased upon changing to the more dilute solution, the bulk volume increased with some soils and decreased with others. Such bulk decreases occurred only in the first passage of 0.25M NaCl following sodium saturation and were attributed to aggregate failure. When 1M NaCl was reintroduced, hydraulic conductivity increased with all soils so tested; bulk volume decreased. Further successive permeations with 1M and 0.25M solutions produced hydraulic conductivity increases with bulk volume decreases on changing from .025M to 1M, and hydraulic conductivity decreases with bulk volume increases on changing from 1M to .025M NaCl. A mechanical explanation, based on a bimodal pore model of the soil and on the way in which variation of stress from point to within the soil affects volume changes of the swelling material and the soil pore-size distribution, is given.
W68-00329

PREDICTION OF THE EFFECT OF MIXED-SALT SOLUTIONS ON SOIL HYDRAULIC CONDUCTIVITY,
Agricultural Research Service, US Department of Agriculture.
B. L. McNeal.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 190-193, Mar-Apr 1968. 4 p, 2 fig, 1 tab, 8 ref.

Descriptors: *Hydraulic conductivity, Permeability, *Ion exchange, Mathematical models, *Expansive clays, Leaching, Saline water, Soil chemistry, Clays, Soil water movement, Soil texture, Soil water, Sodium, Calcium, Irrigation.
Identifiers: *Clay swelling, Salt-affected soils, Sodic soils, Sodium absorption ratio, Mixed-salt solutions, Ionic domains.

A procedure is described for predicting the hydraulic conductivity of soils in the presence of mixed-salt solutions. First, measurement is taken of the absolute hydraulic conductivity of the soil with a single high-salt, high-sodium solution; then the relative hydraulic conductivity of the same sample is measured with a low-salt solution. Calculated interlayer swelling values for soil montmorillonite serve as a frame of reference for predictions. Swelling values are obtained using a simplified domain model for characterizing the exchangeable-cation distribution on Na-Ca montmorillonites. Reliability of the procedure is established with a group of soils having variable clay content but constant clay-fraction mineralogy. The effect of soil texture on relative hydraulic conductivity to mixed-salt solutions appears to be adequately accounted for through the interlayer swelling values used for the predictions. The relationships are presented in nomograms.
W68-00330

TRANSPORT IN SOILS: THE BALANCE OF MASS,
Illinois Agriculture Experiment Station, Urbana, Ill, and US Department of Agriculture, Madison, Wisc.
P. A. C. Raats, and A. Klute.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 161-166, Mar-Apr 1968. 6 p, 25 ref.

Descriptors: *Soil physics, Soil compaction, *Soil dynamics, Soil moisture, Soil water, Soil water movement, *Vadose water, Permeability, *Unsaturated flow, Percolation, Porosity, Deformation, Equations, Kinetics, Mathematical models, Theoretical analysis.
Identifiers: *Continuum theory, Kinematics, Deformable soils, Phases, Gradients, Multiphase flow, Phd thesis.

A mathematical treatment of transport in soils, based upon a continuum theory of mixtures, is proposed. Some of the general features of this continuum theory of mixtures and of its application to soils are discussed. A soil is regarded as a mixture of phases, e.g., an unsaturated soil is regarded as a mixture of a solid phase, an aqueous phase, and a gaseous phase. The idea of balance of mass is considered in some detail, particularly in relation to deformable soils. The integral balance of mass for a certain phase over a certain volume is formulated. Forms are deduced from the integral balance of mass differential. The balance of mass for water in a deformable soil is derived. It is shown that under special circumstances this balance of mass reduces to special forms that appear in the literature.
W68-00348

WATER AND SALT TRANSFER IN SOIL RESULTING FROM THERMAL GRADIENTS,
California Univ., Department of Soils and Plant Nutrition, Riverside, Calif.
L. V. Weeks, S. J. Richards, and J. Letey.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 193-197, Mar-Apr 1968. 5 p, 2 fig, 2 tab, 12 ref.

Descriptors: *Thermodynamics, *Aqueous solutions, Saline water systems, *Thermodynamic behavior, Unsaturated flow, Steady flow, Soil water movement, Diffusion, Kinetics, Porous media, Ion transport, Soils, Transition flow.
Identifiers: *Irreversible thermodynamics, Unsaturated soil, Thermal gradients, Transient flow conditions, Suction heads.

Rate equations were developed from the theory of thermodynamics of irreversible processes. These equations were used to analyze water transfer induced by thermal gradients along a sealed cylindrical horizontal column of Pachappa soil. Functional relations to calculate values of coefficients in the flow equations were determined from experimental data obtained during steady-state flow conditions. The relations were used to compute values of coefficients to calculate flow rates past selected positions along the column during transient flow periods. Suction head (h) values were maintained in a range that could be measured with tensiometers located at 3 positions along the column. Liquid water transfer toward the warm end was assumed to be due to an induced suction head gradient. This transfer was confirmed by sectioning the column at the end of the experiment and measuring the concentrations of Na and Cl and the EC of saturation extracts prepared from the sections. Experimental results are presented in 2 graphs and 2 tables.
W68-00353

ANALYSIS OF STEADY-STATE EVAPOTRANSPIRATION FROM A SOIL COLUMN,
Department of Agriculture and University of Illinois, Urbana, Ill.
F. D. Whisler, A. Klute, and R. J. Millington.
Soil Sci Soc of Amer Proc, Vol 32, No 2, pp 167-174, Mar-Apr 1968. 8 p, 13 fig, 12 ref.

Descriptors: *Evapotranspiration, Soil moisture, *Darcys law, *Root distribution, Hydraulic gradient, *Unsaturated flow, Soil-water-plant relationships, Vadose water, Porosity, Kinetics, Model studies, Theoretical analysis.
Identifiers: *Numerical analysis, Source term model, Vertical unsaturated flow, Flux profiles, Experimental verification.

Numerical analysis is applied to the steady-state flow equation for evapotranspiration from a vertical soil column. The water uptake by the plant roots is incorporated into the flow equation as a (negative) source term. The evapotranspiration rate and its partitioning between plant transpiration and soil evaporation are specified as the top boundary condition. The lower boundary condition is a water table. Results of the analysis for a Pachappa sandy loam give pressure head, water content, source strength, and soil water flux profiles. This study has (1) demonstrated that solutions to the flow equation with a source term can be obtained by numerical means, (2) shown the theoretical influence of the parameters in the source term model on the flow in the soil, (3) qualitatively indicated a transfer of water from wet soil via the root system, and (4) indicated that the source term has little effect on the pressure head profile unless the evapotranspiration rate is about the same order of magnitude as the theoretical limiting value.
W68-00356

ATTENUATION OF SELECTED NITROGEN FORMS BY SORPTION FROM SOLUTION ONTO NATURAL SOILS,
Michigan State University.
Marvin E. Stephenson.
Annual Progress Report on Project to the Office of Water Resources Research, Dept. of the Interior, 1968.

Descriptors: *Sorption, *Nitrate, *Montmorillonite, Nitrogen cycle, Clay minerals.
Identifiers: Anion sorption.

Recent increased interest in problems of groundwater contamination by soluble nitrogen compounds necessitates that a firmer understanding of the interaction between these compounds and the soil matrix must be developed. This work represents the initiating phase of an extensive study of the nitrogen cycle in bounded soil-water systems which will include consideration of principle sources of nitrogen compounds, their retention, change of state and transport within the system, and subsequent release from the circumscribed volume element. Sorption isotherms were developed for soil-solution systems of montmorillonite clay and nitrate. Regions of both positive and negative sorption were delineated for the range of principal variables commonly experience in the natural environment.
W68-00490

THE INFILTRATION OF IRRIGATION WATER INTO THE SOIL,
Dept. of Agricultural and Biological Engineering, Miss. State Univ., State College, Miss.
J. B. Allen, W. R. Fox, C. Chang, and V. F. Alcantara.
Completion Report to the Office of Water Resources Research, Department of the Interior, June, 1968, 41 p.

Descriptors: *Infiltration, *Irrigation, *Soil.

This study was concerned with the operation of furrow irrigation systems in such a manner as to obtain optimum efficiency in water use. That is, it was aimed at determining the schedule of application of water that would achieve the desired results with minimal consumptive use of water. The study consisted of a review of literature and the establishment of mathematical models. A hypothetical numerical example was set up to illustrate the effect of rate, duration, and interruption of inflow on irrigation efficiency. The results of the study are recommendations as to the operation of furrow irrigation systems.
W68-00507

NON STATIONARY PLANE-RADIAL MOTION OF FLUIDS IN COARSE-GRAINED MATERIAL,
Russian Translation Board, Amer. Geophysical Union, Wash., DC.
L. M. Gadzhiyev.
Soviet Hydrol Selec Pap No 6, pp 656-660, 1966. 5 p, 5 ref.

Descriptors: *Hydraulics, Fluid mechanics, Aquifer characteristics, *Darcys law, Turbulence, Hydrostatic pressure, *Mathematical studies, Synthetic hydrology, Reynolds number, Porous media, Elastic deformation.
Identifiers: USSR, Radial flow analysis (Groundwater), Coarse-grained material.

The problem of non-steady state flow of a fluid toward a borehole through coarse-grained material after the cessation of withdrawal is treated mathematically. In coarse-grained material rapid flow is turbulent and does not follow Darcy's law. In plane-radial flow toward a point sink, velocity increases toward the sink because of decreasing

ross-sectional area of flow; therefore at some listance from the well the velocity passes the criti-al point for Darcy's law and flow becomes non-inear or turbulent. Because of non-uniform size of ore space the transition is gradual overall lthough it is abrupt in each individual channel. A uadratic formula proposed by Velikanov is ex-anded and analyzed to solve for velocity at any listance from the sink. It is believed that the formu-a is valid for all Reynolds numbers.
V68-00523

2H. Lakes

CHLOROPHYLL DERIVATIVES AND CAROTENOIDS IN THE SEDIMENTS OF TWO ENGLISH LAKES,
Maruzen Co, Ltd, Tokyo, Japan.
. H. Belcher, and G. E. Fogg.
Rec Res in the Fields of Hydrosphere, Atmosphere, nd Nuclear Geochemistry, pp 39-48, 1966.

Descriptors: *Eutrophication, England, Fresh vater lakes, *History, Chlorophyll, Cores, Oligotrophy, Clear cutting, *Bottom sediments.

Because plant pigments and their derivatives are a art of the sediments deposited in a lake floor and ften are preserved there, an analysis of the sedi-ents for chlorophyll and carotenoids aids in letermining the history of the lake. The authors be-eve that this is true particularly in determinations f the past or present fertility of the lake. The pig-ents are extracted with acetone from cores taken rom bottom sediments in Lake Windermere and Ennerdale Water and a comparison was made etween these analyses, as well as with an analysis f a previous core from Esthwaite Water. Although considerable divergence was discovered, it was ound that the 'chlorophyll'/epiphase ratios in the urface muds were inversely related to the present-lay fertility of the lakes. The authors conclude that Ennerdale Water is becoming progressively more oligotrophic, that Windermere Water was oligotrophic at an earlier time but is now returning o an eutrophic state as a result of forest clearances bout 3000 BC, and that Esthwaite Water is clearly utrophic.
V68-00463

DISSOLVED OXYGEN IN LAKE ERIE, PAST AND PRESENT,
U of Michigan, Ann Arbor.
. F. Carr.
Great Lakes Res Div, Publ 9, pp 1-14, 1962.

Descriptors: *Eutrophication, *Lake Erie, Great Lakes, Lakes, Limnology, *Dissolved oxygen, Thermocline, Hypolimnion, History, Oxygen equirement, Seasonal, Statistics.

The dissolved oxygen content of the waters of Lake Erie varies areally and bathymetrically. Analytical ata assembled for the years 1927 through 1961 how that oxygen depletion in the central basin of he lake has become more extensive over the last 3 ecades. There may have been critically low con-entrations of dissolved oxygen prior to the period eported; however, they may not have been de-ected because of deficiencies in sampling rocedures and techniques. Signs of eutrophication n the waters of Lake Erie began to appear as early s 1929. At the present time there are hundreds of quare miles of bottom waters in which there is no letectable dissolved oxygen during a part of the ear. The vertical distribution of dissolved oxygen s affected strongly by the temperature gradient, nd where the thermocline is absent, the oxygen aturation of bottom waters is usually 60% or more.
V68-00465

EUTROPHICATION OF RESERVOIRS BY ATMOSPHERIC PHOSPHORUS,
. Chalupa.
Sci Pap Inst Chem Technol Fuel and Water, Vol 4, pp 295-308, 1960. 14 p, 1 tab, ref.

Descriptors: *Eutrophication, Lakes, *Reservoirs, Subsurface waters, Surface runoff, Sewage, *Precipitation (Atmospheric), Dusts, Chemical analysis, *Phosphates, Inorganic compounds, Thermal stratification, *Epilimnion, Bottom sediments, Hypolimnion, Chlorophyta, Water-pollution effects, Nutrients, Bibliographies.
Identifiers: Czechoslovakia, Biological requirements, Trophogenous zone.

The mechanisms that supply phosphorus to water bodies are these: underground water, surface runoff, sewage and other wastes, and atmospheric precipitation or dust. Analyses of the precipitation onto the reservoir at Sedlice, Czechoslovakia, show that during a 7-mo period the reservoir (area=35.8 ha) received 3/4 kg of phosphorus pentoxide. During intervals of normal thermal stratification in the reservoir waters, the demands of the organisms in the trophogenous zone cannot be supplied by waters contributed to the epilimnion nor from the dissolved inorganic phosphates in the bottom layers. One of the consequences is that there is a marked reduction in inorganic phosphate dissolved in the surface-water layers. However, precipitation from the atmosphere can, during this interval of deficiency, supply needed phosphates to those surface waters. Calculations indicate that phosphates so supplied can stimulate effectively the primary production of chlorophytes in these waters. In some regions the supply of atmospheric phosphates might be a secondary hazard in eutrophication, a hazard that deserves further study. Ions other than the phosphate ion can also be supplied in similar ways to lakes and reservoirs.
W68-00466

PLANKTON STUDIES OF LAKE MICHIGAN. 2. THIRTY-THREE YEARS OF CONTINUOUS PLANKTON AND COLIFORM BACTERIA DATA COLLECTED FROM LAKE MICHIGAN AT CHICAGO, ILLINOIS,
Dept. of Botany, Eastern Ill. Univ., Charleston, Ill.
K. E. Damann.
Trans Amer Micr Soc, Vol 79, pp 397-404, 1960. 8 p.

Descriptors: *Eutrophication, Plankton, *Lake Michigan, Great Lakes, Lakes, Aquatic bacteria, *On-site data collections, Systems analysis, *Biorhythms, Coliforms, *Aquatic populations.
Identifiers: Chicago, Illinois, Biological relationships.

In his studies of the bacteria and plankton populations in the waters of Lake Michigan at Chicago, Ill, the author found that there is an apparent periodicity in the total plankton in which 2 years of 'low' plankton productivity were followed by 2 years of 'high' productivity. This cyclic pattern lasted from 1926-27 through 1940-41, or through 7 complete 2-yr cycles, before a change occurred. Studies showed that bacteria counts follow closely the total-plankton curve but with a time lag. The plankters might be a growth medium for the indigenous bacteria rather than for coliform bacteria introduced into the water. The analysis over a 33-yr period (1926 through 1958) showed that the standing plankton population increased significantly by an average of 13 plus or minus 4.6 organisms/ml/yr; the average annual plankton population was 1,086 organisms/ml (max in 1945 and minimum in 1931). The average coliform count was 47 (max in 1942, minimum in 1950 and 1952). The author concludes that pollution, as indicated by coliform bacteria, lacks a direct linear relationship with the increasing trend of plankton productivity in Lake Michigan.
W68-00467

REPORT ON THE SANITARY CONDITION OF GENEVA FROM 1957-60 (FRENCH).
Commission internationale pour la protection des eaux du lac Leman et du Rhone contre la pollution.

Commission internationale pour la protection des eaux du lac Leman et du Rhone contre la pollution, Lausanne, Switzerland, 292 pp, 1964.

Descriptors: *Eutrophication, Lakes, Oligotophy, Trophic level, Turbidity, *Municipal wastes, *Water pollution effects, Oxygenation, Decomposing organic matter, Plankton, Hypolimnion, Stagnant water, Epilimnion, Ammonium slats, Pollutants, *Human population, Nitrogen compounds, Phosphorus.
Identifiers: *Lake Geneva, Switzerland, Secchi disc.

Tests made of the waters of Lake Geneva between 1957 and 1960 indicate that the lake is changing rapidly from one originally oligotophic to one that is tending to become eutrophic, this due largely to the increase of population around the shores of the lake. Measurements in the last 50 yr show that water transparency has been diminished by 1.5-2 m and is now no more than 7.8 m. Vast quantities of influent nutrients have increased the plankton growth so much that the oxygen cycle has been deeply disturbed; this has caused a large biological production of oxygen in the epilimnion but not in the hypolimnion where there is not sufficient oxygen to decompose organic materials adequately. Bottom-water oxygen concentrations in winter are as little as 3.65 mg/1, (a saturation index of 31%); its average annual saturation index is 50% as compared to 85% for the total lake. The deep waters may become stagnant. Ammonium salts have increased from an average of 105 tons in 1957 to 350 tons in 1960. Nitrites have recently spread over the entire lake. Increases have been noted in nitrogen and phosphorus. The Rhone River releases only a small fraction of the nutrients that enter the lake. Bacterial contamination correlates with urban areas, but no part of the lake is certainly free from contamination.
W68-00469

EVIDENCE FOR THE EUTROPHICATION OF LAKE ERIE FROM PHYTOPLANKTON RECORDS,
Dept. of Biology, Western Reserve Univ., Cleveland, Ohio.
C. C. Davis.
Limnol and Oceanogr, Vol 9, pp 275-283, 1964. 9 p, 6 fig, 1 tab, 29 ref.

Descriptors: *Eutrophication, Lakes, *Phytoplankton, History, Seasonal, Asterionella, Molosira, Cyclotella, Fragilaria, Plankton, Tabellaria, Synedra, *Lake Erie, Lake Michigan, Great Lakes, Bibliographies, Aquatic algae, Aquatic populations, Limnology.
Identifiers: *Seasonal changes, Plant populations, Numerical analysis.

Long-term records indicate that there has been increasingly rapid eutrophication of the water in Lake Erie. Complete records of cell counts of phytoplankton in water samples taken from the Division Ave Filtration Plant of the Cleveland Div of Water and Heat were recorded for 25 full years since 1919 and for 7 additional partial years in that same interval. The increase in the average quantity of phytoplankton has been consistent, and ranges from counts of less than 500 cells/ml in the early years of record to more recent counts of 1500 or more cells/ml. Spring and fall phytoplankton peaks were not high and did not extend over many days in 1927, but the peaks in 1962 rose to much greater heights in terms of cells/ml and each one extended over several months. Graphs show the winter minima to be short-lived in the later years of record and that failed to develop in some of them. Phytoplankton genera represented in Lake Erie waters have also altered in this interval: The spring pulses have changed from a predominance Asterionella to one of Melosira with some Cyclotella, Fragilaria, and Tabellaria; the fall pulses have shifted from Synedra to Melosira, and finally, to Fragilaria.
W68-00476

2I. Water in Plants

KINETICS OF OXYGEN UPTAKE BY DEAD ALGAE,
Howard Univ., Wash. DC; Michigan State Univ., E. Lansing.
M. M. Varma, and F. DiGiano.
Water Poll Control Fed Jour, Vol 40, No 4, pp 613-626, Apr 1968. 14 p, 11 fig, 6 tab, 16 ref.

Descriptors: Age, Algae, Bacteria, Oxidation, Oxygen, Plants (Organisms), Temperature, Degradation.
Identifiers: Cells, Concentration, Composition, Uptake, Kinetics.

The rate of uptake of oxygen by dead algal cells is independent of the algal cell concentration. The rate of uptake by young cells is greater than that by old cells. Rates increase with temperature up to about 35 degrees C, then decrease sharply. Increased bacterial population will increase the biodegradation of the dead algae. Uptake rates observed ranged from 0.008 mul 0 sub 2/min/mg algae for old cells at 20 degrees C to 0.294 mul 0 sub 2/min/mg algae for young cells at 35 degrees C. Material balances showed that the total actual oxygen uptake was less than the total oxygen required for complete degradation of the substrate because oxidation was incomplete.
W68-00473

THE INFLUENCE OF THE MINERAL COMPOSITION OF THE MEDIUM ON THE GROWTH OF PLANKTONIC ALGAE. PART 2. THE INFLUENCE OF THE CONCENTRATION OF INORGANIC NITROGEN AND PHOSPHATE PHOSPHORUS,
Queen Mary College, Univ of London, England.
S. T. Chu.
J Ecol, Vol 31, No 2, pp 109-148, Dec 1943. 40 p, 15 fig, 1 tab, 51 ref.

Descriptors: *Eutrophication, Nitrogen, Ammonium salt, Nitrates, Phosphorus, Inorganic compounds, *Chemical properties, *Limiting factors, Plant growth regulators, Plankters, Aqueous solutions, Laboratory tests, Cultures, Diatoms, Algae, Desmids, Chlorophytes, Photosynthesis, Silica, Bibliographies.

The growth of planktons is independent of the nitrogen-phosphorus ratio in the solution when these elements are in optimum concentration. The organisms studied were Pediastrum, Staurastrum, Botlyococcus, Nitzschia, Fragilaria, Tabellaria, and Asterionella, and were grown in synthetic media that simulated natural waters. The growth of plankters is not likely to be inhibited by too high concentrations of nitrogen or phosphorus because the upper limits for optimum growth are always higher than the highest concentrations found in ordinary waters. Concentrations of these elements in natural waters frequently may be below the lower limit for optimum growth so that there might be a seasonal limitation due to nutrient deficiency. Optima nitrogen concentrations differ for different organisms, from 0.3 mg/l (Fragilaria) to 5.3 mg/l (Staurastrum) when an ammonium salt is the source; and there is a much more limited range (0.3-0.9 mg/l) when nitrate is the source. The upper limit for optimum nitrogen concentration ranges from 5.3 to 17 mg/l depending upon the kind of organism. The lower limit of the optimum phosphorus concentration ranges from 0.018 to 0.09 mg/l; the range of the upper limit is from 8.9 to 17.8 mg/l when nitrate is the nitrogen source; it is about 1.78 mg/l when ammonium salts are the source.
W68-00485

HYDROLOGIC PROPERTIES OF SEVERAL UPLAND FOREST HUMUS TYPES IN THE LAKE STATES REGION,
Michigan State University, East Lansing, Mich.
Wade L. Nutter.
Ph.D. Dissertation, Department of Forestry, Michigan State University, East Lansing, Michigan. 147 p, 27 fig, 7 tab, 42 ref.

Descriptors: Humus, *Forest soils, *Evaporation, Unsaturated flow, *Soil water, Mulching, *Infiltration, Temperature, Humidity, Radiation, Diffusivity, Percolation, Soil water movement, Soil physics, *Hydrologic properties, Water loss.
Identifiers: Lake States, Humus-soil complex, Forest hydrology.

Ten sites were sampled that included a variety of soil and forest conditions and humus varients of mull, duff-mull, and mor. Rates of evaporation for undisturbed cores of the humus-soil complex, 16.5-cm diameter and 25.4-cm deep, were determined in controlled enviroment chambers by weight loss and water redictribution by gamma radiation. The humus types were separated by their hydrologic properties into four groups, each independent of inter-site mineral soil variation. Evaporation during a 50-day period was at a continuous falling rate lower than the water transmitting properties of the humus-soil complex and the mors lost a greater fraction of the initial water content than either the mulls of duff-mulls. Water flowed against the water content gradient during evaporation in response to an assumed matric suction gradient. The F horizon ceased to lose water between 16 and 30 days but the H horizon continued to lose water at a decreasing rate for the entire period of evaporation. During simulated rainfall the F and H horizons resisted wetting and water advanced as a wetting front in the mineral soil maintaining the nonuniform shape of the initial water content profile.
W68-00497

A QUANTITATIVE STUDY OF INVERTEBRATES FOUND IN CERTAIN WETLAND PLANT COMMUNITIES IN MISSISSIPPI,
Dept. of Wildlife Management, Miss. State Univ., State College, Miss.
Dale H. Arner, D. E. Wesley, and W. G. Anding.
Completion Report to the Office of Water Resources Research, Department of the Interior, June, 1968, 25 p.

Descriptors: *Invertebrates, *Plant community, Reservoir, Cypress slough beaver pond, Drift material, *Standing crop.

Standing crops of invertebrates were determined in certain wetland plant communities during the winter and spring of the year in Mississippi. A bimonthly sampling of thirteen wetland plant communities was made in three different aquatic areas. In one of these areas, drift material consisting primarily of leaf and twig debris was also sampled. The three areas sampled were a man-made reservoir, a cypress slough, and an old beaver pond. Water and soil chemistry work revealed only small differences with the exception of organic matter and phosphates which were higher in the beaver pond than in the other two areas. Drift material, Myriophyllum brasiliense and Polygonum hydropiperoides provided the earliest aquatic habitat and the only winter habitat available for invertebrates. Drift material had a greater number and weight of invertebrates for the entire sampling period than any wetland plant community studied. Ceratophyllum and Spirodela were the last plants to appear. From the results of this study, drift material, Cabomba, and Myriophyllum would be of the most value to breeding wood ducks in providing the most animal food during the late winter period while drift material, Ceratophyllum, Potamogeton foliosus, and Spirodela would be the most productive of invertebrates for the newly-hatched ducklings during the late spring and summer period.
W68-00505

2J. Erosion and Sedimentation

CERTAIN STATISTICAL PATTERNS IN THE MOVEMENT OF STREAMBED SEDIMENTS,
Russian Translation Board, American Geophysical Union, Washington, DC.
B. S. Shteynman.
Soviet Hydrol Selec Pap No 6, pp 650-652, 1966. 3 p, 2 fig, 5 ref.

Descriptors: *Sediment transport, Flow, Running waters, *Sediment discharge, Sediment load, Sand waves, *Bed load, *Statistical methods, Frequency analysis, Least squares method, *Sampling, Statistical models, Turbulent flow, Streambeds.
Identifiers: *Dunes (Bed load), USSR, Kura River, Theory of random, Functions, Statistical patterns.

Dune movement of sand in stream beds was studied statistically. The magnitude of discharge pulsates in time as dunes pass the point of observation, and discharge rates may be treated as random values. Patterns can be obtained only statistically. A turbulent stream is an auto-oscillating mechanical system. Assuming the frequency to be proportional to average stream velocity and if strength of impulse decreases as frequency increases, on the basis of the integral limiting theory of probabilities, the pulsation of bottom sediment discharge conforms to the Gaussian law of distribution. Data from the Kura Delta substantiate this conclusion. In measuring average discharge with 100 independent nonequivalent accurate samples, the arithmetic mean of separate measurements was a=0.30 kg per sec, mean square deviation = 0.15, reliability = 0.95 and student's ratio t = 1.989 and the accuracy of the measurement h = 0.02. The confidence interval is 0.32 less than x less than 0.28, and therefore 0.29 kg per sec is a fully acceptable sediment transport value. The average load computed from 20 samples equals the average of 100 samples. It is best to sample so as to collect from several dunes passing the sampling point rather than to take all samples from one dune.
W68-00522

EROSION OF COHESIVE SEDIMENTS,
American Society of Civil Engineers, Hydraulics Division.

ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6044, pp 1017-1049, July 1968. 33 p, 21 fig, 64 ref, 1 append. Task Committee on Erosion of Cohesive Materials, Committee on Sedimentation.

Descriptors: Sedimentation, *Hydraulics, *Sediments, Agricultural engineering, Channels, *Cohesive soils, Erosion, Laboratory tests, Design criteria, Soils, Water quality, Rainfall-runoff relationships, Estuaries.
Identifiers: *Agricultural land, Scour resistance, Shallow-flow hydraulics.

Described is the relationship of cohesive sediments to problems associated with agricultural land and channel improvements, design criteria, and laboratory and field research. As the final report of the Task Committee on Erosion of Cohesive Materials, Sedimentation, Hydraulics Division, ASCE, current literature is reviewed and recommendations are made for practical applications to design and for further research. A compilation of design equations and charts and some data not generally available are included. An extensive bibliography (64 ref) is presented.
W68-00535

FLUVIAL SEDIMENT IN UTAH, 1905-65--A DATA COMPILATION,
U S Geological Survey.
J. C. Mundorff.
Utah Div of Water Rights Inform Bull No 20, 400 p, 1968. 2 fig, 1 tab, 7 ref.

Descriptors: *Utah, *Sediments, Suspended load, Particle size, Methodology.

Identifiers: *Basic-data compilation, *Fluvial sediments, Particle fall velocity.

Published and unpublished basic data available on fluvial sediment in Utah are compiled for the 1905-65 period. Improvements and refinements in methods of collecting and analyzing sediment samples are mentioned. Frequency of observation in sedimentation studies is reported since it may be useful to determine long-term trends, seasonal relations between sediment concentrations and streamflow, and predictable discharge characteristics of streams. Standard analyses of suspended-sediment samples provide 2 different types of data: suspended-sediment concentration and particle-size distribution. Sedimentation methods, based on particle fall velocity, include: visual-accumulation-tube method, pipet method, and bottom-withdrawal tube method. Report contains 400 p of tabulated data.
W68-00543

SOIL MECHANICS AND FOUNDATIONS, CHAPTER 3--SEEPAGE OR FLOW OF WATER THROUTH SOILS,
Oklahoma State University, Stillwater.
James V. Parcher, and Raymond E. Means.
Charles E Merrill Publishing Co, Columbus, Ohio, pp 101-180, 1968. 80 p, 68 fig, 1 tab, 16 ref.

Descriptors: *Hydrology, *Soil mechanics, Dam construction, Soil properties, Excavation, *Foundations, Hydraulics, Darcys law, *Flow nets, *Seepage, Soil strength, Flow rates, Potentiometric level, Aquifers, Water table, Wells, Stratification, Geologic formations, Engineering geology.
Identifiers: Engineering aspects of hydrology, Textbook.

Chapter 3 of 'Soil Mechanics and Foundations,' a basic text on soil properties for foundation engineers, concerns the effects of moving groundwater on soil strength, foundation construction methods, and design criteria. The general topics covered are basic conditions of flow, flow line calculations, flow net construction and analysis, calculation of seepage forces on soil, design of filters, flow of water into wells, time-drawdown curves, analysis of well arrays, twodimensional flow analysis, well interference, design of well arrays to control water table position, flow in anisotropic materials, and determination of permeability of stratified deposits.
W68-00572

2K. Chemical Processes

DYNAMICS OF CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER, BOTTOM MUDS, AND AQUATIC LIFE IN A LARGE IMPOUNDMENT ON A RIVER,
Auburn University Agricultural Experiment Station.
J. M. Lawrence.
Zoology-Entomology Department Series Fisheries No 6, Agricultural Experiment Station, Auburn University, March 1968; OWRR FINAL PROJECT B-005-ALA. [216] P, [20] FIG, [81] TAB.

Descriptors: Multiple-purpose reservoirs, Turbidity, Water temperature, Water analysis, Hydrosols (Soils), Stratified flow, Aquatic plants, Freshwater fish, Dissolved oxygen, Light penetration.
Identifiers: Eufaula Lake, Total carbon, Total nitrogen, Chattahoochee Lake.

Chemical and physical characteristics of waters at various depths and locations in a multi-purpose, 45,000 acre reservoir (Lake Eufaula) on the Chattahoochee River, its headwaters and tailwaters, were determined at regular intervals over a 3-year period. Determinations included pH, temperature, turbidity, light penetration, conductance, dissolved oxygen, alkalinity, calcium, magnesium, sodium, potassium, copper, zinc, orthophosphate, ammonia nitrogen, carbon, iron, manganese. Dried, cored bottom-soil samples and hydrosol samples were extracted with ammonium acetate and quantities of following exchanged elements were determined: calcium, magnesium, sodium, potassium, copper, zinc, iron, manganese, cadmium, chromium, nickel, cobalt, molybdonum, lead, and phosphorus. Samples of several species of rooted aquatic plants and several species of fish were collected, preserved by freeze-drying, ashed, ash dissolved in acid, and quantities of same elements listed above were determined. Total nitrogen and total carbon content of all dried soil, fish, and plant samples were also determined. During the 3-year study period many chemical and physical characteristics of reservoir waters were in a constant state of change. Generally, the total carbon content of water decreased during this period while the ammonia nitrogen and orthophosphates contents remained fairly constant. Chemical composition of soils and aquatic life also remained fairly constant. Zinc, copper, lead, cadmium, and chromium contents in aquatic life in reservoir were greater than in tributary ponds.
W68-00579

2L. Estuaries

ESTUARINE LANDS OF NORTH CAROLINA: LEGAL ASPECTS OF OWNERSHIP, USE AND CONTROL,
Institute of Government, University of North Carolina, Chapel Hill.
David A. Rice.
Institute of Government, University of North Carolina, pp 1-52, April, 1968. 52 p, 184 ref.

Descriptors: *North Carolina, *Estuaries, *Ownership of beds, *Tidal waters, Navigable waters, Non-navigable waters, Tidal marshes, State jurisdiction, Public rights, Leases, Accretion (Legal aspects), Bank erosion, Estuarine fisheries, Prescriptive rights, Oysters, Clams.

The author traces the historical development of legal doctrines concerning estuarine ownership, use, and control from the developments of the English Common Law and the American colonial period through three evolutionary periods of North Carolina state law. North Carolina development of the navigability doctrine as applied to ownership of estuarine land is analyzed. Legal principles regarding ownership and use of estuarine resources insofar as they are classified ferae naturae or domitae maturae are treated. North Carolina law regarding ownership of lands between the high and low water marks in light of conflicting decisional precedent is discussed. Statutory modification of common law rules concerning accretion, relic tion, avulsion, and erosion is presented. Application of principles of adverse possession to estuarine lands, construction of deeds to estuarine lands and legal proceedings determining the validity thereof, and state power to regulate the use of estuarine land and resources in general are treated.
W68-00606

ESTUARINE LANDS OF NORTH CAROLINA: LEGAL ASPECTS OF OWNERSHIP, USE AND CONTROL,
Institute of Government, University of North Carolina, Chapel Hill.
David A. Rice.
Institute of Government, University of North Carolina, pp 1-14, April, 1968. 14 p, 49 ref.

Descriptors: *North Carolina, *Estuaries, Tidal waters, Ownership of beds, Public rights, State jurisdiction.

Under the English common law the English Crown claimed ownership of territorial waters which were affected by tides, as well as the underlying lands. These lands were considered jus privatum of the king and subject to an exclusive grant by the King of rights or privileges therein to a private individual. However, a grant of high land adjacent to tidal waters did not generally convey the submerged lands. On the other hand a grant of high land adjacent to non-tidal waters did convey the lands thereunder absent specific indicia to the contrary. Later, tidelands became regarded as jus publicum, held in public trust and not subject to alienation by the king. However, Parliament, as the representative of the public, could convey jus publicum. The public had a right to fishing and navigation in tidal waters thereby precluding exclusive fishery grants by the Crown. The Carolina colony adopted English common law insofar as colonial conditions permitted, thus giving the Proprietorship no greater power to alienate jus publicum than the English Crown. Throughout the colonial period the ebb and flow of the tide theory was still applied as the guide in distinguishing jus publicum from other types of land.
W68-00607

ESTUARINE LANDS OF NORTH CAROLINA: LEGAL ASPECTS OF OWNERSHIP, USE AND CONTROL,
Institute of Government, University of North Carolina, Chapel Hill.
David A. Rice.
Institute of Government, University of North Carolina, pp 14-29, April, 1968. 14 p, 46 ref.

Descriptors: *North Carolina, *Estuaries, Tidal marshes, *Navigable waters, State jurisdiction, *Leases, Clams, Oysters, Tidal waters.

A 1777 statute, apparently permitting entry upon land underlying navigable waters, was held not to permit such entry because such lands were necessary for public purposes. After 1831 only entries upon marshlands less than 50 acres between previously surveyed lands or over 2000 acres and unsurveyed were valid. An 1837 decision held the flow of the tide theory of navigability applicable despite 2 earlier decisions holding that theory inapplicable in North Carolina. The legislature corrected the situation in 1847 but the courts have since held that all entries upon land beneath non-tidal waters between 1837 and 1847 were valid. Oyster and clam leases authorized in 1859 appear to be valid today. In 1959 the state shifted from the grant and entry system to direct sale or leases. All lands underlying navigable waters, defined as 'navigable in fact', were declared state property. Such lands may not be granted in fee but easements may be given. Swamp lands, however, may be sold in fee and are defined as lands too wet for cultivation except by drainage. A 1965 statute authorizing termination of outstanding oyster and clam leases with renewal at higher fees was held unconstitutional.
W68-00608

ESTUARINE LANDS OF NORTH CAROLINA: LEGAL ASPECTS OF OWNERSHIP, USE AND CONTROL - pp 29-52,
Institute of Government, University of North Carolina, Chapel Hill, North Carolina.
David A. Rice.
Institute of Government, University of North Carolina, Chapel Hill, North Carolina, pp 29-52, April, 1968. 23 p, 89 ref.

Descriptors: Boundaries, *North Carolina, Ownership of beds, Patents, *Estuaries, Estuarine fisheries, Accretion (Legal aspects), *Navigable waters, Bank erosion, Prescriptive rights, State jurisdiction, Tidal waters, *Non-navigable waters, Tidal marshes.

The navigability test of accomodation of sea vessels may have evolved to accomodation of any form of contemporary water transport. Fish and migratory water creatures are public property. Non-migratory species may be privately owned. Therefore shellfish lease owners own the shellfish. Such leases permit cultivation of artificial beds only and give no rights in natural beds. Apparently the legislature may specifically grant lands underlying navigable waters. Such lands cannot be acquired through entry. Legislative amendment of common law rules of avulsion, accretion, reliction and erosion permits all land naturally raised above highwater marks of navigable waters to vest in adjoining riparian

owners. Natural deletions may be reclaimed by them. Nonrnaturally raised land vests in the state. Adverse possession title is available to the state and private parties. The state may not assert title against proper adverse possession. Determination of boundaries by natural marks absent other description is particularly important in construction of marshland deed terminology. The state may regulate estuarine lands to the extent that regulation neither impairs the contractual obligations of the state to individuals nor amounts to taking land without due process and just compensation.
W68-00609

03. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

PRECIPITATION OF SULFATE SALTS FROM SALINE SOLUTIONS,
W R Grace and Company, Clarksville, Md.
Jacob Block, and O. B. Waters, Jr.
Office of Saline Water Res and Develop Progr Rep No 305, 59 p, Jan 1968. 26 fig, 34 tab, 17 ref, 1 append.

Descriptors: *Chemical precipitation, Gypsum, Anhydrite, *Saline water, Brines, Cost-benefit ratio, Chemical reactions, Solubility, Solutes, Sea water, Temperature, Salinity.
Identifiers: Mirabalite, Thenardite, *Sodium chloride concentration, Graphics, Phase equilibrium studies, Penta salt.

An account is given of progress in one part of saline water conversion and of the economics of its application. In sulfate-salt and phase-equilibria studies, the CaSO sub 4-Na sub 2 SO sub 4-H sub 2 O system was studied from 25-100 deg C at salinities from 0.04.0 molal NaCl. The solid phases found were gypsum, insoluble anhydrite, mirabalite, thenardite, and 3 double salts (glauberite, labile salt, and penta salt). The problem of evaporating the concentrated brine by-product resulting from desalination of sea water is considered, and a cost analysis was made of recovering sodium sulfate from this sea-water brine. Preliminary results indicate that at the current price level of sodium sulfate ($22.50/ton), this process would be uneconomical.
W68-00347

3B. Water Yield Improvement

WATER RESOURCES OF THE LAC QUI PARLE RIVER WATERSHED, SOUTHWESTERN MINNESOTA,
US Geological Survey.
R. D. Cotter, and L. E. Bidwell.
US Geol Surv Hydrol Invest Atlas HA-269, 4 sheet, 1968.

Descriptors: *Water supply, Water storage, Fishing, Wildlife, *Water quality, Recreation, *Surface waters, *Groundwater, Aquifers, Water balance, Drawdown, Minnesota, Water sources, Water utilization, *Streamflow.
Identifiers: Lac qui Parle, Minnesota.

The Lac qui Parle River system is a potential source of a moderate amount of water. None of the streams flow during long droughts, and they flood because of snowmelt, ice jams, and excessive precipitation. The streams and lakes are important for recreation. Surface water is of good quality but hard. Most water used is groundwater, and potential for its future development is good. Surficial sand yields several hundred gpm; but the sand is not widespread and is easily contaminated. Buried sand and gravel aquifers can yield several hundred gpm. Cretaceous sandstone and sand aquifers generally yield less than 100 gpm in the north central part of the area. The water is soft, but may be high in sodium, chloride, boron, and total dissolved solids. Precambrian rocks are used sparsely but are not a dependable aquifer. The atlas consists of 4 plates with 2 block diagrams, lithologic and rock chemistry diagrams, water budget charts, summary charts of all water sources, quality of water map and charts, municipal-supply potential and use, surface-water discharge, and flow-duration and specific conductance charts and maps. Also included are aquifer maps and yield charts; groundwater chemical-quality maps, charts, and cross sections; and time-drawdown curves. The major maps are on a scale of 1:250,000.
W68-00359

REVIEW OF THE WORK OF THE GEOLOGICAL SURVEY OF QUEENSLAND IN THE DEVELOPMENT OF WATER RESOURCES IN THE GREAT ARTESIAN BASIN,
Geological Survey of Queensland, Brisbane, Australia.
D. J. Casey.
Geol Surv of Queensland Rep No 23, 19 p, 1968. 2 fig, 6 tab, 38 ref.

Descriptors: *Project planning, *Water resources development, Data collections, *Aquifers, Geological surveys, Stratigraphy, Boreholes, Seismic studies.
Identifiers: Australia, *Great Artesian Basin, Artesian water, Artesian aquifers, Geological Survey of Queensland.

The role of the Geological Survey of Queensland in the development of water resources in the Great Artesian Basin is summarized in relation to the geology of the area. A brief geologic description is given of the Carpentaria, Eromanga, and Surat Basins which are 3 component basins divided by basement ridges of the Great Artesian Basin. Sources of information useful in groundwater investigations are reviewed, although the data available therefrom were not necessarily obtained during the period of this report. These data sources include regional mapping by government geological parties, water and petroleum drilling, gamma-ray logging of water bores, geophysical (chiefly seismic) surveying, palynology, and stratigraphic drilling. Recommendations for future work are proposed and include (1) sampling, evaluating, and cataloging of information on borehole cuttings, (2) a program of hydrogeological studies and statement of methods, and (3) water quality investigations.
W68-00518

AVAILABILITY OF GROUND WATER IN ADAMS COUNTY, NEBRASKA,
US Geological Survey.
C. F. Keech, and V. H. Dreeszen.
US Geol Surv Hydrol Invest Atlas HA-287, 1 sheet, 1968. text, 7 fig, 6 map, 7 ref.

Descriptors: *Groundwater, *Water wells, *Hydrologic data, Aquifers, Drill holes, *Water quality, Chemical analysis, Water levels, Data collections, Hydrogeology, Water table, Groundwater basins, Water level fluctuations, Water sources, Observation wells, Water yield, Specific capacity, Nebraska, Municipal water.
Identifiers: Chemical analysis (Water), Water level measurements, Adams County.

The relationship of groundwater occurrence to geologic conditions in Adams County was investigated by the U.S. Geological Survey in cooperation with the University of Nebraska. Much of Adams County with its gentle slopes and well drained soil is well suited to irrigation. In 1964 nearly 65,000 acres were irrigated with well water. Annual precipitation averages 25 in., mainly in thunderstorms. The high quality groundwater is in surficial unconsolidated Pleistocene deposits and semiconsolidated Pliocene deposits whose combined thickness ranges from 100 to 500 ft. Annual pumpage of about 50,000 acre-ft from 765 wells exceeds recharge; the water table has been declining since 1952. Yields range from 50 to 2,500 gpm. Dissolved solids content of the water, a calcium bicarbonate type, ranges from less than 100 to over 300 ppm. In addition to text, the Atlas consists of 3 maps, scale 1: 250,000, showing geology, thickness of Pliocene and Pleistocene rocks, depth to water, transmissivity, and well locations. Smaller maps show soils and water level decline. Hydrographs, geologic cross sections, and a graph of the number of wells drilled each year since 1945 are also included.
W68-00525

WATER RESOURCES OF THE MIDDLESBORO AREA, KENTUCKY,
US Geological Survey.
D. S. Mull, and R. J. Pickering.
US Geol Surv Rep of Invest 9, 51 p, 1968. 13 fig, 7 plate, 6 tab, 41 ref, 1 append.

Descriptors: *Water resources, *Geohydrology, *Kentucky, Duration curves, Hydrographs, Frequency analysis, Floods, Low flow, Water management (Applied), Aquifers, Water quality, Chemical analysis, Water levels, Water table, Springs, Specific capacity, Artesian wells.
Identifiers: *Well data, Pumping tests, Water-level measurements, Flood peak, Flood data, Flood frequencies, Middlesboro area.

Water resources information for the Middlesboro area is summarized as part of the statewide study of water and mineral resources. The quantity and quality of groundwaters and surface waters are described; the aquifers, water use, and natural as well as man-made conditions affecting optimum development of water resources are discussed. A dependable water supply is available from a reservoir in a protected drainage basin; ample groundwater is available for present use and future needs. Most of the groundwater is in conglomerates and sandstones of the Pennsylvanian Lee Formation. Artesian wells capable of producing as much as 100 gpm each can be developed; a well and a spring each of that capacity are already in use. Shallower rocks of the Pennsylvanian Breathitt Group and the shallow alluvium can be developed for domestic and modest industrial supplies. Fractures in the disturbed rocks aid recharge and circulation so that generally aquifer water is satisfactory for most uses with little more treatment than iron removal. Further development of surface water would require impoundment. Surface water quality is slightly impaired by acid mine drainage and waste disposal. Flood hazards are reduced by control structures.
W68-00529

WATER RESOURCES OF THE MISSISSIPPI EMBAYMENT EAST OF THE MISSISSIPPI RIVER,
U S Geological Survey, Jackson, Miss. and Memphis, Tenn.
E. H. Boswell, and E. M. Cushing.
Trans of Soc of Mining Eng of AIME, Vol 241, No 2,pp 137-148, June 1968. 12 p, 17 fig.

Descriptors: *Water resources development, *Hydrologic aspects, Geologic control, *Geohydrologic units, Aquifer characteristics, Water utilization, *Appraisals, Water quality, Stratigraphy, Alluvium, Mississippi River, Surface waters, Underground storage, Subsurface mapping, Porosity, Physical properties, Aquicludes.
Identifiers: *Hydrologic framework, *Aquifer systems, Mississippi embayment, Geologic sections, *Potential water supply, Vertical leakage.

The water resources of a 52,000-sq mi region of the Mississippi embayment east of Mississippi River are described; the potential aquifer system yields and the factors controlling their development are discussed. Of 12 major aquifer systems present, 5 are in deposits of Cretaceous age, 6 are in deposits of Tertiary age, and one is in the almost flat-lying Quaternary alluvial deposits that are on and

hydraulically connected in places with the older aquifers. The multiple artesian systems and the alluvial aquifer adjacent to the Mississippi River are virtually undeveloped sources of fresh water because only a fraction of their available storage is used. Potential yield of the 12 systems is 25,000 mgd; only 600 mgd is now withdrawn. Total water stored is 1,600 trillion gal. Water of less than 500 ppm dissolved-solids content lies at depths less than 1,000 ft; water of less than 1,000 ppm lies in places at depths more than 3,000 ft. Iron is a common troublesome constituent. Water originating in the region and leaving as streamflow averages 50 million acre-ft (45,000 mgd) annually. An additional 375 million acre-ft originates from outside the region and leaves the region as streamflow in an average yr. The considerable base flow of some streams generally has low dissolved-solids content.
W68-00532

CALCULATING WATER INFLOW TO A RESERVOIR BY INDIVIDUAL TRAVEL-TIME CURVES WITH VARYING PARAMETERS,
Russian Translations Board, Amer. Geophysical Union, Wash., DC.
A. B. Kryzhanovskaya.
Soviet Hydrol Selec Pap No 6, pp 653-656, 1966. 4 p, 2 fig, 4 ref.

Descriptors: *Streamflow, Discharge (Water), Floods, Hydraulics, *Hydrographs, *Stage-discharge relations, Streamflow forecasting, River forecasting, Synthetic hydrology, Stream gages, Discharge measurement, Computers, Analog computers, Hydroelectric plants.
Identifiers: *Travel-time curves, USSR, Streamflow summation, Stream gaging, Kiev reservoir.

In an attempt ot solve the problem of calculating inflow to any reservoir when only water level recorders are located at the upstream end of backwater reaches from dams, and discharge gaging stations are much farther upstream, the flows into the Kiev and Kanev reservoirs were studied. A calculation was made of inflow to the 2 hydraulically connected reservoirs by summing the discharges at the upper gaging stations on the Dnieper and its tributaries. The sum was compared with discharge measured at the Kiev dam added to discharges of the tributaries between it and the Kaney dam, and yielded an accurate total for the river system. Previous attempts to sum the discharges of the upstream tributaries failed because travel time curves of the Dnieper and Pripet Rivers are substantially different. An analog computer method was devised to sum the curves by taking into account the differences of morphology of the streams. The calculated summary curves were very close to the observed curves. A large flood gaged in 1931 was used as a test of the method's accuracy under extreme conditions. The accuracy was good.
W68-00541

WATER-RESOURCES APPRAISAL OF SMOKE CREEK-SAN EMIDIO DESERT AREA, NEVADA AND CALIFORNIA,
Geological Survey.
Patrick A. Glancy, and F. Eugene Rush.
Nev Dep of Conserv and Natur Resources Water Resources-Reconnaissance Ser Rep 44, 57 p, Apr 1968. 3 fig, 1 plate, 2 photo, 18 tab, 23 ref.

Descriptors: *Nevada, *California, Water quality, Geologic control, Groundwater basins, Alluvium, Aquifers, *Hydrologic aspects, Irrigation, Standards, Water utilization, Natural recharge, Playas.
Identifiers: *Water resources appraisal, Perennial yield, Transitional storage reserve, Natural discharge, Geologic terrane.

A reconnaissance investigation was conducted in the Smoke Creek-San Emidio Desert area of Nevada and California. The objectives were: (1) to appraise the source, occurrence, movement, storage, and chemical quality of water; (2) to estimate the annual recharge and discharge interacting in the groundwater reservoir; (3) to evaluate the valley surface-water resources; and (4) to estimate perennial yield. Precipitation, during winter months mostly, accounts for practically all the area water. Geologic terrane controlling the natural hydrologic system consists of consolidated-rock mountain masses bordering and separating the valleys, and alluvial-mantled valley floors. Known and developed aquifers are in alluvial deposits at relatively shallow depths. Chemical analyses of 25 water samples indicate good to very poor quality. Water in shallow groundwater reservoirs upgradient from playa areas is suitable for most purposes. Values are tabulated for the principle hydrologic factors evaluated in this reconnaissance.
W68-00544

CHEMICAL CHARACTER OF WATER IN THE FLORIDAN AQUIFER IN SOUTHERN PEACE RIVER BASIN, FLORIDA,
Geological Survey.
M. I. Kaufman, and N. P. Dion.
Florida Div of Geol Map Ser No 27, 1 sheet, Oct 1967. text, 11 fig, 7 ref.

Descriptors: *Water quality, Geochemistry, Hydrogeology, Maps, *Groundwater movement, Water temperature, Permeability, Dissolved solids, Chlorides, Artesian wells, Standards, Groundwater recharge, Water utilization, Potable water, *Florida, Pressure head, Sulfates.
Identifiers: *Chemical character, Water availability, Groundwater discharge, Water use, Floridan aquifer, Peace River basin.

An analysis is given of areal and vertical variations in permeability, water movement, and chemical character and temperature of the water in the artesian Floridan aquifer, southern Peace River basin, Florida. Hydrogeologic conditions and areal and vertical range in temperature and chemical character of the groundwater are graphically illustrated and described. The temperature and chemical variations indicate deep circulation and active solution of evaporites; these waters then ascend along a linear fault zone of greater permeability than the adjacent rocks and are discharged from the artesian aquifer as warm, mineralized water beneath Peace River. For example, wells drilled near the river to 600-700 ft below mean sea level yield water with dissolved solids content more than 500 ppm, whereas wells of greater depth east or west of the river yield water less than 250 ppm dissolved solids. Large quantities of water, meeting recommended U.S. Public Health Service standards for potable use, may be obtained in northeast Manatee County, northwest and east Hardee Counties, and northeast De Soto County.
W68-00558

3D. Conservation in Domestic and Municipal Use

CONSERVATION OF WATER IN AGRICULTURE, INDUSTRY, AND MUNICIPAL USE,
Carnegie Institution of Washington, Washington, DC.
Edward A. Ackerman.
Water Resources Bull, Vol 4, No 1, pp 3-20, Mar 1968. 18 p, 4 fig, 1 tab.

Descriptors: *Water conservation, Pesticides, Sediments, *Hydrologic cycle, Meteoric water, Evaporation, Evapotranspiration, Precipitation (Atmospheric), Quality control, *Water management (Applied), Decision making, *Agricultural chemicals, Waste disposal, Planning, Social values, Communication, Aesthetics, Pollutants.
Identifiers: *Atmospheric reservoir, *Quality conservation, *Water supply, Biosphere, Development, Urban impact, Recycle.

Factors to be considered in planning research and development are related to water conservation practices. Effective conservation lies in recognition by policy leadership of the following: (1) Water problems are not divisible; (2) effective water management means integrated management; and (3) future conservation actions must be based on broad and effective public communication. A conservation system, including man and his environment, is described as a variant of the hydrologic cycle. Maintenance of water quality is as important as conserving quantity; pollution control, as a part of conservation, is being increasingly recognized and attacked in urban and industrial areas. The more difficult problem of agricultural pollution by sediment, leached salts, pesticides, and other sources is receiving more attention. Objectives for water quality conservation are presented: (1) The traditional approach which stresses natural waste disposal functions of streams but does not consider aesthetic and other values; and (2) a new approach which proposes that water as a part of the human environment, like air, should be as clean as we can make it. Integrated planning and development is a central objective.
W68-00340

WATER RESOURCES OF KING COUNTY, WASHINGTON, with a section on SEDIMENT IN STREAMS, by R. C. Williams,
US Geological Survey.
Donald Richardson, J. W. Bingham, and R. J. Madison.
US Geol Surv Water-Supply Pap 1852, 74 p, 1968. 32 fig, 12 tab, 2 plate, 63 ref.

Descriptors: Municipal waters, *Surface waters, Streams, Groundwater, *Precipitation (Atmospheric), Snow, Rain, Storms, *Runoff, Floods, Flood control, *Water quality, *Water pollution, Sediment load, *Water pollution treatment, Municipal wastes, Water supply, Forecasting, Washington, Water sources, Water utilization.
Identifiers: Seattle, Washington, King County, Washington.

King County, which extends from Puget Sound to the crest of the Cascade Range, contains Seattle and a 1/3 of Washington's 3 million people. Large and growing population will increase water-supply and pollution problems. Average precipitation ranges from 30 to over 150 in. Estimated evapotranspiration is from 15 to 24 in.; therefore, runoff in the 3 major river basins averages over 50 in. Runoff and precipitation are highest in winter and lowest in summer and fall. The Green-Duwamish Valley is partly protected by a dam; the Snoqualmie Valley is not so protected, and its development is rapidly increasing the flood-damage potential. Sediment quantities are low. With little treatment surface water is suitable for fisheries, municipal, industrial, and domestic use. Most recoverable groundwater is in the Puget Sound Lowland which contains large amounts of unconsolidated glacial deposits. Bedrock contains little groundwater. Most groundwater is of excellent quality except for high iron content. Over 80% of water used is from municipal supplies, which can be developed to supply over 2 million people with 300 gallons per day. Up to 1965, pollution was the most serious water problem, but a sewage treatment program of the Municipality of Metropolitan Seattle will eliminate discharge of waste into Lake Washington.
W68-00354

3F. Conservation in Agriculture

IRRIGATION--PRESENT AND FUTURE,
California Univ., Davis, Calif.
D. W. Henderson, and B. A. Krantz.
Plant Food Rev, Vol 14, No 1, pp 12-13, 16, 1968. 3 p, 1 photo.

Descriptors: *Irrigation, Irrigation practices, Soil-water-plant relationships, Irrigation programs, Sprinkler irrigation, Drainage effects, Farm management, Irrigation engineering, Water allocation (Policy), Desalination, Nuclear powerplants, Water users, Irrigation districts.
Identifiers: Irrigation planning, Dynamic agriculture, Variable soils, Resources conservation.

The present use of irrigation is surveyed; predictions and recommendations are made for its development and extension. The advantages of irrigation include control and uniformity of plant production, usually in western areas where the climate is favorable and predictable. Irrigation systems cost as much as $700 per acre to install. Water costs as much as $100 per acre and skilled labor is expensive. To offset high costs the irrigator must grow high-value crops, and little diversity is possible. Soils and crops are usually not uniform in water requirement; water quality is variable and various methods of application are advantageous for different situations. Mechanization is creating a requirement for more uniform plants. Irrigation aids in producing uniform plant height, spacing, and growth rate. New regional water plants are being implemented, an example of which is the 'California Water Plan' to irrigate over 600,000 new acres in the San Joaquin Valley. Inter-basin diversion is proposed for the North American West. Desalination might be made economical for future industrial-food-power-factories. Government action is necessary for proper development.
W68-00312

CONTROLLING FARM SOIL AND WATER LOSSES,
Purdue University, Lafayette, Ind., and Georgia Univ., Athens, Ga.
J. V. Mannering, and A. R. Bertrand.
Plant Food Rev, Vol 14, No 1, pp 5-8, 1968. 4 p, 5 fig, 1 photo, 1 tab.

Descriptors: *Soil conservation, Contour farming, Cover crops, *Water loss, *Erosion control, Runoff, Sediment control, Soil erosion, Water conservation, Soil structure, *Soil-water-plant relationships, Raindrops, Impact (Rainfall), Nutrients, Leaching, Mulching, Strip cropping.
Identifiers: *Farm soil, Sod planting, Soluble chemicals, Tillage system, Crop residues, Water-holding capacity.

Farm practices necessary to conserve soil and reduce agricultural water wastage are reviewed, and methods for wastage abatement are suggested. The same methods may be used for industrial sites, residential developments, and roadsides. Soil texture affects water-holding capacity, infiltration rate, drainage and nutrient-holding capacity. Erosion removes a greater proportion of finer than coarser particles. Nutrients are held on the active surfaces of the finer particles and are thus selectively removed in erosion. Selective removal of finer particles also reduces the soil water-holding capacity. Erosion may be lessened by reducing raindrop impact, reducing amount of runoff, slowing runoff velocity, and managing soils to reduce erosion. Using only level land for crops is very effective where it is practical. Leaving crop residues on the surface breaks up raindrops and slows runoff. Various tillage systems are designed to control water flow. Winter cover crops are effective in high-rainfall areas. High-density crops and vigorous early growth are effective in maintaining good ground cover, and the resulting larger residues help in the nonproductive season.
W68-00314

WATER USE ON THE FARM--HOW IT CAN BE IMPROVED,
Soil Conservation Service, US Department of Agriculture, Washington, DC.
Tyler H. Quackenbush.
Plant Food Rev, Vol 14, No 1, pp 9-11, 1968. 3 p, 1 tab, 3 photo.

Descriptors: *Irrigation efficiency, Flood irrigation, *Irrigation design, Furrow irrigation, Irrigation canals, Irrigation practices, Water users, Sprinkler irrigation, Water rights, Water contracts, Drainage effects, Soil-water-plant relationships, Farm management.
Identifiers: *Irrigation water price policy, Water rights policy, Water metering, *Agricultural education.

It is recommended that the efficiency of water for agricultural use, about 85% of total national water consumed, be improved. Of over 90 million acre-ft of water delivered to irrigated farms, only about 47% is used beneficially to produce crops; the rest runs off or percolates below the root zone. Although this water may be reused, its quality is impaired. Water is often relatively cheap so that wastage is less costly than wages of skilled employees. Often there is no penalty at all for excessive use. Many allocation methods are not based on need or actual use. Delivery methods are often inefficient. Good metering methods must be used not only at the point of delivery to the consumer, but also at the point of application, so that total application to each site is known. Education of the user so that he will know the exact requirements of his crops at all times is important. Equipment must be installed only after careful planning.
W68-00536

INTEGRATING FARM AND WATERSHED PLANNING IN SOIL AND WATER RESOURCE MANAGEMENT,
Manitoba Department of Agriculture, Winnepeg, Manitoba and Iowa State University, Ames, Iowa.
M. Cormack, and J. F. Timmens.
J of Soil and Water Conserv, Vol 23, No 3, pp 84-88, May-June 1968. 5 p, 1 photo, 2 tab.

Descriptors: *Watershed management, Erosion control, Flood control, Land management, *Soil management, Surface runoff, *Farm management, Contour farming, Crop production, Planning, Estimated benefits, Cost-benefit analysis, Estimated costs, Iowa, Resource allocation, Linear programming.
Identifiers: Capital investment (Farming).

The Hound Dog Creek watershed, a 3,140-acre drainage in Fremont County, Iowa, was studied to determine the type of watershed development that would yield maximum return to farmers consistent with minimum runoff damage. Net crop and livestock production minus hydrologic damage was determined under 3 alternative situations: (1) continued predevelopment use, (2) development using existing capital resources, and (3) development using additional capital resources. Cost-benefit analysis indicated that land use and conservation practices (2) and (3) used with profit-maximizing farm plans would reduce interfarm erosional damages in the watershed by reducing runoff. Flood damage would be reduced 6-10%. Net average farm revenue would rise from (1) $7,458 to (2) $8,775 to (3) $10,643. The study suggests a need to integrate farm and watershed planning for more efficient management of soil and water resources in small watersheds.
W68-00564

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on THE Surface

PIERCE FAMILY, INC V MAGNESS CONSTR CO (OBSTRUCTION OF NATURAL FLOW FROM SURFACE RUNOFF).

235 A2d 268 (Del 1967).

Descriptors: Civil law, Water law, Legal aspects, *Obstruction to flow, Natural flow doctrine, Surface drainage, *Surface runoff, Runoff, *Drainage water, *Delaware.
Identifiers: Civil law rule.

The natural drainage of plaintiff's land was blocked by the defendant in developing lower lands. The defendant installed a 24 inch pipe to carry off the water. The plaintiff seeks to enjoin this blockage on the ground that the pipe may be sufficient for the present, but it will become insufficient in the future if higher land is developed. The issue decided is whether or not an upper landowner can compel a lower landowner to provide drainage facilities to carry off an amount of water increased artificially above the natural drainage level. The general rule is that a lower owner may not artificially obstruct the natural flow of water upon his land so as to cause the water to back up and flood the land of an upper owner. Also the upper owner may not artificially increase the flow of water upon lower lands above its natural volume. The defendant can be compelled only to make provision for drainage sufficient to take care of the natural flow of water presently existing.
W68-00420

BUFFALO SEWER AUTHORITY V TOWN OF CHEEKTOWAGA (DRAINAGE OF SURFACE RUNOFF INTO LOWER GROUND DRAINAGE SYSTEM).

20 NY 2d 47, 228 NE 2d 386 (1967).

Descriptors: Drains, *Drainage, Drainage ditches, Sewers, Storm drains, Surface runoff, Surface drainage, Drainage systems, Drainage pattern (Geologic), Drainage practices, *Riddance (Legal aspects), Storm drains, Judicial decisions, *New York, *Remedies.
Identifiers: *Storm waters, Natural drainage, Upper estate, Lower estate, *Injunction.

This is an action for an injunction to restrain discharge of storm waters from defendant town into plaintiff city. The town was owner of an upper estate and the city owner of a lower estate. In its natural state surface water drained from the town into the city. The town constructed streets, receiving basins and storm drains which discharged into the city's sewers greatly increasing the flow on the lower owner, and causing the city's sewers to back up. The court held an upper owner cannot by artificial means concentrate and discharge upon the lower owner's land quantities of water which if left alone would flow elsewhere. The Court granted the injunction, provided the city could come up with a reasonable co-operative plan to allow the town adequate drainage.
W68-00421

SURFACE WATER DRAINAGE,
Notre Dame Law School, Notre Dame, Indiana.
Donald V. Dobbins.
Notre Dame Lawyer, Vol 36, No 4, pp 518-526, August 1961. 9 p, 68 ref.

Descriptors: *Surface runoff, *Repulsion (Legal aspects), Civil law, Reasonable use, Illinois, *Water law, *Surface drainage, Judicial decisions, Legislation.
Identifiers: *Civil law rule, *Reasonable use rule.

Three basic rules of law are applied to the drainage of diffused surface waters. They are the civil law, common enemy, and reasonable use rules. In its pure form the civil law rule grants the upper landowner an easement of natural flow over the lower land, but it does not grant the upper owner any right to hasten the flow of water. The common enemy rule, applied in its strict sense, gives the upper landowner the right to use any means he chooses to rid his land of surface water; and at the same time the lower landowner may use similar means to repel it. The reasonable use rule, essentially negative in its concept, does not give the owner any right to improve the drainage of his land but imposes liability for any injury which results from such an improvement if, upon consideration of all the relevant circumstances, it is unreasonable. Modification of the civil law and common enemy rules and the evolution of the reasonable use rule are discussed. The article concludes that differences between the three rules remain in spite of legislative and judicial modifications.
W68-00427

UHLHORN V UNITED STATES GYPSUM CO (BOUNDARY CHANGE BY ACCRETION OR AVULSION IN SHIFTING RIVER CHANNEL).

366 F 2d 211 (8 Cir 1966)

Descriptors: *Accretion (Legal aspects), *Avulsion, State jurisdiction, High water mark, Thalweg, Boundaries (Property), Navigable rivers, Channels, Islands, Erosion, Riparian rights, Riparian lands, Water law, Legal aspects, State governments.

The question was whether certain land known as Massey Towhead on the Mississippi River was located in Tennessee or Arkansas. The land originally formed as accretion on the Arkansas side of the thalweg. The thalweg, and state boundary, was in a channel which curved around the accretion. In 1938, as the result of flooding, a new channel was formed across the accretion. A special Master found that although avultive processes caused the change in the channel, it was not a 'true' avulsion because Massey Towhead, at the time of the shift, was not above the ordinary high water mark. Consequently, he concluded that the state boundary shifted as if by accretion. The Court held that where a state's boundary is fixed by a navigable river, such boundary can not be changed by any action of the river except the gradual and imperceptible process of erosion and accretion. The channel was not changed by a gradual process and therefore the state boundary did not change. The Court also held that the rule of avulsion was applicable even though the land was below the high water mark, because it was a solid and compact land mass which was discernible, intact and identifiable before and after the change.
W68-00433

BOURIS V LARGENT (OBSTRUCTION OF NATURAL FLOW BY DAM CONSTRUCTION).
236 NE 2d 15 (1968).

Descriptors: Riparian rights, Riparian waters, Natural flow doctrine, *Reasonable use, Alteration of flow, Relative rights, Boundaries (Property), Remedies, Lakes, *Illinois, *Diversion dams, Legal aspects.

This was an action by a lower riparian owner against an upper riparian owner for mandatory injunction to remove a dam. The upper owner counterclaimed for cost of building the dam. The Circuit Court rendered judgment for plaintiff on his claim and dismissed defendant's counterclaim. The appellate court affirmed. Defendant was the owner of and abutting on a small lake. Plaintiff purchased and on a smaller lake to the south. The two lakes are separated by a 30 foot causeway. Prior to plaintiff's purchase defendant had constructed a dam across the south end of the northern lake. Evidence indicated that water previously flowed naturally between the 2 lakes and that defendant's dam lowered the level of the southern lake. The Court found that defendant's dam was an unreasonable use by an upper riparian owner when considered together with the unreasonable effect upon the lower owner. Plaintiff's rights were not determinable as of date he acquired the property, since he acquired the property, since he acquired the rights of the former owner with the purchase of the property. Since defendant had no right to construct the dam, plaintiff was not liable for the cost thereof.
W68-00440

BELLATTI V ALLSPACH (RIPARIAN RIGHTS ALTERED BY CHANGE IN FLOW OF A SEWER SYSTEM).
79 111 App 2d 44, 222 N E 2d 909 (1967).

Descriptors: Drainage districts, Drainage systems, Tile drains, Legal aspects, Drainage engineering, *Illinois, Administrative agencies, Remedies, Easements, Legislation, Irrigation practices.

Plaintiffs sought a mandatory injunction requiring the defendant-drainage district to repair a breach in a 27 in. tile under a statute prohibiting obstruction or impairment of drains without consent of all landowners. Because the tile was completely enclosed, the drain acted as a hose keeping water in the drain clear to the end of the tile regardless of the elevation of the ground through which the tile passed from south to north. Plaintiffs tapped this water supply for irrigation purposes during the dry season. The breach was ordered by the defendant in order to construct a ditch running east and west to the south of plaintiffs' property. In denying plaintiffs' injunction the court found that the purpose of the statute was to insure that waters will not accumulate on higher land because of the acts or omissions of lower owners and gave the plaintiffs no right to a continuation of an unnatural flow of water. The breach did not change the course of the former sewer system or interfere with the 'falling away' of water on plaintiffs' land, but only changed the direction of flow within the sewer system.
W68-00445

THE MANATEE: ECOLOGY AND USE FOR WEED CONTROL,
Fisheries Laboratory, Dept. of Agriculture, Georgetown, British Guiana.
W. H. L. Allsopp.
Nature, No 188, p 762, 1960.

Descriptors: *Eutrophication, *Aquatic weed control, Weeds, Channel improvement, *Aquatic animals, Mammals, Herbicides.

An effort was made to find natural predators for controlling weeds growing in ditches. The author describes the use made of the manatee for this kind of control. During 1959-60 2 manatees 7.5 ft (2.3 m) long were able to clear a canal 22 ft (6.1 m) wide and 1,600 yd (1460 m) long in 17 weeks. They kept the passage clear of weeds, apparently quite efficiently. These big animals are docile, easily bruised, and slow reproduction. The author states that the animals are far more effective and lasting than the usual chemical weedicides. They are harmless to fish and other water animals.
W68-00459

CONTROL OF WEEDS ON IRRIGATION SYSTEMS,
Bureau of Reclamation, US Dept. of the Interior, Wash., DC.
R. B. Balcom.
US Dept Int, Bur Recl, 1949. 140 p.

Descriptors: *Eutrophication, *Weed control, *Irrigation systems, Flow rates, *Classification, Transpiration, Irrigation efficiency, *Cost analysis, Systems analysis, Benefits, Ditch grass, Systematics, Clear cutting, Herbicides, Biocontrol, 2-4-D, Sprays, Sterilants.
Identifiers: Combustion, Temporary controls.

The high cost of the control of weeds in irrigation systems is discussed in this manual. Weeds cause flow rates to be reduced, large amounts of water to be lost through transpiration, and the efficiency of irrigation systems to be greatly reduced. Sections in the manual are: (1) The ditch weed problem; (2) Weed types and classifications; (3) Weed prevention; (4) Ditchbank weed control (includes effects of various chemicals e g, selective herbicides, 2,4-D, contact herbicides, oil sprays, soil sterilants, sodium chlorate, and prochlor; burning, mowing, etc); and (5) Waterweed control, e g, with benoclor, sodium arsenite, and copper sulfate. The author states that 'while more permanent control methods require a greater initial cost, this may be compensated for many times over during the life of a project through the elimination of temporary measures which must be taken year after year.'
W68-00460

PRODUCTION ECOLOGY OF A SANDY BEACH,
Marine Laboratory, Aberdeen, Scotland.
J. H. Steele, and I. E. Baird.
Limnol and Oceanogr, Vol 13, No 1, pp 14-25, Jan 1968. 12 p, 8 fig, 2 tab, 11 ref.

Descriptors: *Ecology, *Diatoms, *Beaches, Benthic flora, Tracers, Chlorophyll, Carbon, Bays, Estuaries, Runoff, Particle size, Waves (Water), Intertidal areas, Tides, Phytoplankton.
Identifiers: *Sandy beach, Carbon-14 radioactive tracers, Production ecology, Sublittoral.

In a general study of food chains in a small sandy bay in Lock Ewe, Scotland, an investigation of production ecology was made. The vertical distribution of pigments and organic matter and the yearly cycle of production in a sandy beach are described for low-water and sublittoral depths (13m). Chlorophyll and carbon content of the populations attached to sand grains increase with increasing depth of overlying water. At low-water mark, viable diatom populations are found to 20-cm depth in sand. The effects of wave action, however, keep these populations at a relatively low level so that the yearly primary production of benthic flora is in the range of 4-9 g C m to the minus 2 power. Methodology included carbon-14 uptake and organic carbon particle size measurements as well as various methods of chlorophyll-a estimation.
W68-00545

ORARI-WHIHI-TEMUKA RIVERS FLOOD CONTROL SCHEME,
South Canterbury Catchment Board, New Zealand.
C. W. Williams.
Soil and Water, Vol 4, No 3, pp 11-13, Mar 1968. 3 p.

Descriptors: *Flood control, Abatement, *Channel improvement, Check structures, Cutoffs, Dikes, Diversion, Erosion control, *Flash floods, *Floodways, Levees, Design flood, Flood routing.
Identifiers: New Zealand, Orari, Whihi, Temuka Rivers, Canterbury, New Zealand, 100 year flood, 50 year flood.

Because average annual flood loss without flood control was 5%, the Orari-Whihi-Temuka flood control scheme was undertaken. The flooding is caused by rapid runoff from the head waters in the mountains and unstable aggrading alluvial channels downstream. Farming practice has aggravated the conditions by changing the type and amount of vegetative cover and introducing obstructions, such as growing willow fence posts, to river flow. Only 1/6 of a large flood could pass the willows of the lower Orari. The objects of the flood control shceme are to prevent Orari floodwaters from entering the other systems, to prevent flooding of 120,000 acres of farmland, and to provide adequate drainage for farmland. The design flood of 45,000 cu ft per sec, a 100 yr event for the Orari and 50 for the others, will be controlled by diverting 9,000 cu ft per sec from the Orari into Coopers Creek and handling the remaining 36,000 by channel straightening, other channel improvements, and levees. Drainage has improved to the extent that 20-30% of formerly wet areas are now in wheat. Productivity of once-flooded areas has increased over 400%, and stock numbers, 600%.
W68-00548

ENVIRONMENTAL PARAMETERS AND MARSH FORAMINIFERA,
Scripps Institution of Oceanography, California Univ., La Jolla, Calif.
John S. Bradshaw.
Limnol and Oceanogr, Vol 13, No 1, pp 26-38, Jan 1968. 13 p, 10 fig, 13 ref.

Descriptors: *Marshes, Tidal effects, Wetlands, Environmental effects, Bays, Sediments, Salinity, Monitoring, Diurnal distribution, Water temperature, Oxygen demand, Marsh plants, Aquatic habitats, Histograms, Hydrogen ion concentration, Analytical techniques, California, Instrumentation, Ecotypes.
Identifiers: *Marsh foraminifera, Microhabitats, Tidal flats, Algal masses, Seasonal variations, *Multifactor environment recorder.

A multifactor instrument, designed to record continuously many environmental factors in situ, provided data which are analyzed in connection with a study of marsh foraminifera. Continuous records of environmental factors were made in a marine marsh of air and water temperature, light intensity, wind speed, oxygen concentration, pH, Eh, sodium ion, sulfide ion, salinity, and tide height. Vertical changes in pH, Eh, oxygen, and sulfide were relatively large compared to other variations. Horizontal differences in pH and oxygen were due to varying amounts of vegetation. Variations due to tidal action affected all water parameters. At ebb tide, salinities increased from approximately 34% to as much as 50%, while pH decreased from approximately 8.2 at high water to as low as 6.8. Diurnal variations were large, with % oxygen saturation values varying from approximately 10% to as high as 270%. Maximum and minimum values as well as the % of time these values fall between a given set of conditions are presented, and various applications to seasonal occurrences of foraminifera are discussed.
W68-00562

STUDY OF THE RELATIONSHIP BETWEEN SURFACE AND SUBSURFACE FISSURE-KARST WATERS IN THE AY RIVER BASIN,
Russian Translations Board, Amer. Geophysical Union, Wash., DC.
P. V. Molitvin.
Soviet Hydrol Selec Pap No 6, pp 557-567, 1966. 11 p, 3 fig, 3 tab, 6 ref.

Descriptors: *Karst, Carbonate rocks, Caves, *Drainage effects, Mine drainage, *Sinks, *Subsurface drainage, Underground streams, Stream gages, Dye releases, Tracers, Surface-groundwater relationships, Springs, Bedrock, Gaging stations.
Identifiers: *USSR, Bauxite mine water control, Stream gaging, Surface-underground drainage relations, *Groundwater runoff.

A series of dye tracer experiments were performed to learn source, rate, and path of movement of waters in karst channels in order to determine the best method for draining a bauxite mine in a karst area. The Ay basin, in the western foothills of the Southern Urals, includes both karst and nonkarst terrain. Calcareous rocks occur 400-500 m thick, and the entire thickness has solution openings which are much better developed in the upper 230-240 m. The region has almost no surface runoff. The flow of the Ay and its tributaries is lost when it enters the karst. Dye tracer studies showed direct connection between the river and the mine site with flow rates up to 100 m per hour, and also that there are no groundwater divides corresponding to the divides between tributaries of the Ay. Hydrometric studies showed from 12.0 million cu m to 19.85 million cu m per yr diverted underground. After a proposed diversion of the river around the karst area, enough flow would remain to require a pumping station with a capacity of 5,500 cu m per hr in the mine.
W68-00565

FLOODS AT ARECIBO, PUERTO RICO,
Geological Survey.
I. J. Hickenlooper.
U S Geol Surv Hydrol Invest Atlas HA-271, 1 sheet, 1968. 2 fig, 1 map.

Descriptors: *Floods, Streams, Surface waters, *Puerto Rico, Karst, Flood protection, Dams.
Identifiers: Flood frequencies, Arecibo, Puerto Rico, Indirect flood, Measurements.

The areas inundated in the floods of Sept 13, 1928 and Oct 13, 1954 are delinated on a 1:20,000 scale topographic base map. The greatest known flood occurred Aug 8, 1899, but its extent has not been determined. Since 1942, the regimen of the river has been altered by dams upstream from the study area. The areas inundated and the 2 flood profiles shown are for valley conditions at the time of the floods. The recurrence intergal of the 1928 flood is estimated to be 34 yr, and the 1954 flood, 20 yr. The intervals of 2 other floods are tabulated.
W68-00577

LABORATORY AND FIELD TESTS OF POND SEALING BY CHEMICAL TREATMENT,
Tennessee Univ., Knoxville.
John I. Sewell.
Tennessee Agricultural Experiment Station Bulletin 437, March, 1968. 25 p, 10 fig, 7 tab, 10 ref.

Descriptors: *Seepage, *Permeability, *Reservoir leakage, *Reservoirs, *Darcy's law, Lagoons, Ponds, Farm ponds, Water holes.
Identifiers: *Pond sealing.

Over 500 permeability tests with 8 soil-dispersing chemicals were conducted on 9 Tenn. soil types. Sodium pyrophosphate treatments at 2 and sodium carbonate (soda ash) at 5 tons per acre were the most successful. These treatments costing approximately $375 per acre for chemicals reduced the permeability of the 9 soils to from 1/10 to 1/100 of the permeability of identical but untreated samples. Laboratory test results suggest that at least 1 ft. of well compacted relatively impervious seal blanket over porous areas of pond floors is necessary to prevent rupture of the seal blanket under 10-ft. heads. Nine seriously leaking ponds were treated according to the best procedures developed in the laboratory. Eight of these treated ponds held well; and between Jan. 1 and Nov. 15, 1967, the mean ratio of minimum to maximum pond depths was 0.74. One pond developed serious leaks which were successfully repaired to a pond depth of 6 ft. The field tests substantiated the laboratory tests in that chemical treatments can, for certain situations, be effective in reducing reservoir seepage.
W68-00580

WATER LAW IN MICHIGAN--SECTIONS I-IIB,
Theodore Lauer, Dominic King, and Wilbert L. Ziegler.
In Water Resources and the Law, pp 423-455, 1958. Michigan Univ. Law School, Ann Arbor, 32 p, 164 ref (see W68-00581).

Descriptors: *Consumptive use, *Riparian rights, Riparian land, Bank erosion, Ownership of beds, Accretion (Legal aspects), Reasonable use, Avulsion, Domestic water, Municipal water, Prescriptive rights, *Water law, Remedies, *Michigan, Watercourses (Legal), Water rights, Surface waters, Navigable waters, Non-navigable waters.
Identifiers: Great Lakes Submerged Lands Act.

The article reviews the law of Michigan governing consumptive use, diversion, pollution, and drainage of water, and also uses of water for navigation and recreation. The law applying to surface waters is first examined. Riparian ownership is analyzed as to what land is riparian, the interests required for an individual to assert riparian rights, ownership of submerged lands, and the effect of natural modification of the shoreline. It is noted that Michigan law regarding the ownership of beds of navigable waters has developed along two distinct lines, one dealing with beds of inland streams and lakes and the other involving the bed of the Great Lakes. The law governing the use of surface water is set forth as it applies to consumptive uses. The reasonable use doctrine, which applies to consumptive uses on streams and lakes, is analyzed. Domestic uses, municipal uses, and prescriptive rights to a consumptive use of water are discussed. Remedies for a wrongful consumptive use include injunction and compensation for damages. Only individuals injured by the wrongful use are proper party plaintiffs.
W68-00600

WATER LAW IN MICHIGAN--SECTION IIB,
Theodore Lauer, Dominic King, and Wilbert L. Ziegler.
In Water Resources and the Law, pp 455-489, 1958. Michigan Univ. Law School, Ann Arbor, 39 p, 222 ref (see W68-00581).

Descriptors: Surface waters, *Michigan, *Water law, Water rights, *Water pollution, Storage, Navigable waters, *Navigation, Remedies, Prescriptive rights, Watercourses (Legal), Public rights, Riparian rights, Fishing, Hunting, Swimming, Legislation, Administrative agencies, Trapping.
Identifiers: Michigan Water Resources Commission, Public nuisance, Private nuisance.

The law governing non-consumptive uses of surface water in Michigan is examined. Such uses include pollution, detention, navigation, and related uses. The reasonable use doctrine provides a foundation for determining the degree to which persons can pollute a waterbody. The important distinction between pollution as a public or private nuisance is discussed. Remedies for unreasonable pollution include injunctive relief, monetary damages and self help. A prescriptive right to pollute can be gained by adverse and continuous pollution for fifteen years. Prescriptive rights to pollute are limited to uses and amounts made for the full prescriptive period. State and local control of pollution is controlled by statute, the primary responsibility resting with the Michigan Water Resources Commission, which has broad power to set standards and to regulate pollutants. Detention is governed by the reasonable use test. Tests for determining whether waterways are open to the public for navigation, the rights of the public incident to navigation, the comparative rights of riparian owners and navigators, and the rights of the public to fish, swim, hunt, and trap upon and adjacent to the state's waterways are discussed.
W68-00601

WATER LAW IN MICHIGAN--SECTION II C,
Theodore Lauer, Dominic King, and Wilbert L. Ziegler.
In Water Resources and the Law, pp 490-522, 1958. Michigan Univ. Law School, Ann Arbor, 33 p, 180 ref (see W68-00581).

Descriptors: *Michigan, *Water law, Surface runoff, *Surface drainage, Obstruction to flow, Flow augmentation, Drainage patterns (Geologic), Remedies, Judicial decisions, Condemnation, Prescriptive rights, Dams, Water policy, Damages, Impoundments, Watercourses (Legal), Artificial watercourses.
Identifiers: Concentration of flow, Public policy, Natural rights, Property rights, Estoppel.

This section discusses in detail Michigan law dealing with the drainage of water. Interference with surface water drainage usually takes one of three forms: (1) obstruction of flow; (2) increase of flow; and (3) artificial concentration of flow. The first part deals with wrongful interference with the legally protected drainage pattern and with remedies available to those whose rights are adversely affected by such interferences. The second part examines the manner in which changes may legally be made in the existing drainage pattern. The general rule in Michigan is that it is wrongful to disturb the existing legally protected pattern of drainage. Each of the forms of interference with drainage is discussed in relation to streams and lakes, artificial watercourses, and diffused surface water. Remedies available to an injured party in surface water drainage problems include monetary damages, injunctive relief, and self-help. Rights constituting the structure of the existing drainage pattern include natural rights, rights originating through judicial declaration of public policy, and rights acquired by grant or lease, condemnation, prescription and estoppel.
W68-00602

DROGEN WHOLESALE ELECTRIC SUPPLY, INC, V STATE (INTERFERENCE OF NATURAL RIVER FLOW BY BRIDGE CONSTRUCTION),

7 A D 2d 763, 276 N Y S 2d 1015-1019 (1967).

Descriptors: Watercourses (Legal), Floods, Overflow, *River flow, Flood damage, *Negligent inun-

dation, *Surface runoff, *Flood forecasting, New York, Judicial decisions.

In 1934, the State built a new bridge across the Susquehana River to replace an old one. The southerly approach to the new bridge was raised substantially, causing lands to be inundated in flood periods that had never been flooded before. The plaintiffs' claimed that the damage to the property was a result of the bridge's interference with the natural flow of the river and that it should have been anticipated by the State. The trial court held for the plaintiffs. On appeal, the State argued that the waters causing the damage were surface waters and disavowed any duty to permit the free flow of surface waters under its causeway. The Supreme Court, Appellate Division, rejected the State's contention, ruling that a finding of surface waters causing the damage could not be supported by the evidence in the record. Instead, the evidence showed unequivocally that the southerly approach blocked the natural flood plain and constituted a negligent interference with the flow of the river. Waters cease being characterized as surface when they reach a stream channel.
W68-00610

NICHOLSON V DOYLE (RELATIVE RIGHTS IN ALTERATION OF FLOW OF SURFACE WATER).
218 A 2d 689-691 (Vt 1966).

Descriptors: *Vermont, *Culverts, *Alteration of flow, *Relative rights, Watercourses (Legal), Pipes, Remedies, Damage, Judicial decisions, Obstruction to flow, Streams, Artificial watercourses, Natural stream, Northeast U S, Running waters, Stream flow, Roads.
Identifiers: *Upper estate, Lower estate, Damages (Legal aspects).

This was an action for damages caused by flooding. A small brook ran across plaintiff's property, then across defendants' property, then into a 24 in. culvert under a road. Defendants placed a 24 in. pipe in the bed of the brook from plaintiff's property line to the culvert, and graded over this for a lawn. Plaintiff's cellar was damaged by flooding from the brook. The burden was on plaintiff to show that defendant's actions were a cause of the flooding. The placing of the pipe by defendants was found to be not such a substantial deviation from the course or size of the brook as to add to the burden of plaintiff's land additional waters. Testimony showed that prior to defendant's construction water had backed up on plaintiff's property to the same extent. Judgment for defendant was affirmed.
W68-00616

STATE V CAIN (LIMITATIONS ON LANDFILL OPERATIONS BY LAKE FRONT OWNERS).
236 A 2d 501-507 (Vt 1967).

Descriptors: *Vermont, Water levels, *Boundaries (Property), Boundary disputes, Legal aspects, Judicial decisions, *Low water mark, Lakes, Water level fluctuations, Watercourses (Legal).
Identifier: *Ordinary low water mark.

This was an action by the state to enjoin landowners from proceeding with a landfill operation, in the form of a dike, in a portion of Lake Champlain immediately in front of the owners' shore property. The landowners intended to put the dike at the low water mark and fill in behind it to create usable land adjacent to the usable land area already owned by them. The Supreme Court of Vermont ruled that in order to determine the ordinary low water mark of the lake, which would be the boundary line to which the landowners could fill, the average of the normal low water marks for a given period of time must be used. The use of the average of the lowest water level reached in each year for a given number of years was not the ordinary low water mark, but the extraordinary low water mark, which was an improper method of determining property boundaries.
W68-00636

4B. Groundwater Management

AN ATLAS OF LONG ISLAND'S WATER RESOURCES,
US Geological Survey.
P. Cohen, O. L. Franke, and B. L. Foxworthy.
NY Water Resources Comm Bull 62, 117 p, 1968. 50 plate, 131 ref.

Descriptors: *Groundwater, *Saline water, *Saline water--freshwater interfaces, Confined water, Artesian wells, Water balance, Streamflow, Evapotranspiration, Runoff, *Recharge, *Discharge (Water), *Recharge wells, *Pumping, *Sewage disposal, Thermal pollution, Groundwater mining, Planning, Skimming, Aquifers, Water management--applied.
Identifiers: Water budget, Zone of diffusion, Skimming wells, *Long Island, Barrier injection wells, Pumping troughs, Recharge basins.

The groundwater reservoir is a saturated, wedge-shaped mass of deposits 0 to 2000 ft thick. The saturated volume is estimated to be 180 cu mi and dewatering would yield 3-6 trillion gal. The artesian-pressure surface is a few ft lower than the water table near the middle of the island and a few ft higher near the coasts. Annual precipitation averages 44 in. (1600 mgd); evapotranspiration, 21 in.; and recharge, 23 in. (820 mgd). Average streamflow is 340 mgd of which 95% is discharged groundwater. Estimated nautral groundwater discharge is 820 mgd--320 to streams, 470 to the sea, 15 to springs, 15 to evapotranspiration. Dissolved solids average less than 50 ppm. Fresh and salty water are hydraulically connected, and local overdevelopment has caused salt-water intrusion. Recharge of air-conditioning water has caused thermal pollution, and there is some sewage and industrial pollution. Proposals for sea-water encroachment control include: continuing present regulations; using barrier injection wells, pumping troughs, recharge basins, and skimming-wells that reduce stream discharge; and controlling encroachment to establish a new equilibrium.
W68-00335

GROUND-WATER RESOURCES OF NUECES AND SAN PATRICIO COUNTIES, TEXAS,
US Geological Survey.
George H. Shafer.
Tex Water Develop Board Rep 73, 129 p, May 1968. 18 fig, 14 tab, 58 ref.

Descriptors: *Groundwater, *Municipal water, *Irrigation water, Stock water, Domestic water, Transmissivity, Groundwater mining, Injection, Saline water, Oil industry, Waste disposal, Texas, Water sources, Water utilization, *Saline water intrusion, Water wells, Brine disposal, Aquifer characteristics.
Identifiers: Corpus Christi, Texas, Nueces and San Patricio Counties, Texas, Gulf Coast aquifer.

In 1964, 15.6 mgd was pumped, of which public supply used 2.3; irrigation, 8.2; industrial, 2.1; and domestic and stock, 3.0 mgd. The coefficient of transmissibility ranges from 1500 to 24,000 gpd/ft. Further development of a few mgd may be possible without depletion of salt-water intrusion in northwest San Patricio County, where yields could be 1700 gpm. A few million acre-ft might be withdrawn economically from storage. Large quantities of moderately saline water are available. Injection wells are considered the best way to dispose of oil-well salt water, but only 23.9% of the total quantity in Nueces County and 9% in San Patricio County is injected.
W68-00355

GROUND WATER IN ECONOMIC DEVELOPMENT,
Utah State University, College of Engineering, Logan.
D. F. Peterson.
Ground Water, Vol 6, No 3, pp 33-41, May-June 1968. 9 p, 5 fig, 3 tab, 11 ref.

Descriptors: *Groundwater, Water supply, *Water resources development, Water quality, *Water management (Applied), *Saturated soils, Canal seepage, Wells, Drainage wells, Shallow wells, Saline water intrusion, Economics, Water policy, Waste water disposal, Crop production, Groundwater mining.
Identifiers: *Israel, *West Pakistan, Economic development, Potential water supply, Water needs, Waterlogging.

Described are the effects of large-scale groundwater developments for irrigation on the economics of Israel and West Pakistan. Groundwater furnishes over 1/2 the total water supply in Israel. Water management also makes it possible to use surface water and reclaimed sewage as firm sources. By the mid-1970's, Israel will be using all available fresh waters and will have to use desalinated water to increase supplies. Efficient use of water resources has improved the economy so that more expensive sources will be economical in the future. Between 1948 and 1965 the value of crops rose from 44.4 million pounds to 271.1 million; irrigation, from 208,000 ac ft to 880,000; irrigated area, from 75,000 acres to 395,000. Since 1890, in West Pakistan level terrain and leaky canals have caused waterlogging and salinity of over 25 million acres of irrigated land though water supplies were only partly adequate for irrigation. By the 1950's starvation threatened. Since 1960, groundwater development by the government resulted in 3,500 tube wells of 3 cfs capacity, and 30,000 private wells of 1 cfs. Agricultural production and fertilizer use are rapidly increasing as both drainage and water supply improve. Groundwater mining may yield annually about 28 million ac ft.
W68-00357

GROUNDWATER AND BEDROCK DELINEATION IN SOUTHEASTERN MICHIGAN,
Wayne State University.
Andrew J. Mozola.
Annual Progress Report on Project to the Office of Water Resources Research, Dept. of the Interior, 1968.

Descriptors: *Bedrock topography, *Glacial overburden, *Groundwater pollution, Groundwater levels, Hydrogeology, Geomorphology.
Identifiers: Southeastern Michigan, Environmental geology.

Major objective involved is delineation of the preglacial drainage pattern and changes imposed upon this pattern by repeated glaciation in order to provide basic data for future ground-water investigations and development in an eight-county metropolitan area. Existing oil, gas, water well, and test-boring records were used to compile on a county basis, bedrock topography, glacial drift thickness, and water-level maps and revise, whenever possible, existing bedrock and surficial geologic maps. These should be of considerable interest and use to individuals concerned with local or regional planning activities. Present findings indicate (1) bedrock surface (350-400 ft. relief) is a highly dissected one, (2) age chronology of the Pleistocene section (0-500 ft) is essential in differentiating between pre-glacially and glacially carved bedrock valleys, and (3) increasing urbanization strongly points to contamination of Pleistocene and Paleozoic aquifers; the former primarily by domestic septic tank concentrations and the latter, particularly in carbonate terrain with shallow overburden, by septic tanks and the induced infiltration of polluted surface waters by heavy groundwater withdrawal.
W68-00491

PLEISTOCENE GEOLOGY AND GROUND WATER RESOURCES, TOWNSHIP OF ETOBICOKE,
Ontario Department of Mines, Toronto, Canada.
A. K. Watt.
Ontario Dep of Mines Geol Rep 59, 50 p, 1968. 3 fig, 1 map, 9 photo, 3 tab, 5 chart, 5 ref, 2 append.

Descriptors: *Groundwater, *Geologic control, *Hydrologic data, Aquifer characteristics, Water control, Groundwater movement, Water utilization, Data collections, Springs, Water sources, Observation wells, Water yield, Glacial drift, Gravels, Sands, Till, Bedrock, Water-level fluctuations.
Identifiers: Canada, *Etobicoke, Ontario, Toronto, Wells data, *Test holes, Water level measurements, Chemical analyses (Water).

Details are presented of the Pleistocene geology and groundwater resources of Etobicoke Township, York County, Ontario, Canada. This is the 2d in a series of reports on townships with special groundwater problems. After World War II a rapid increase in residential and industrial growth caused a water shortage. A test-drilling program failed to find additional water supplies, and the Metropolitan Toronto Corporation took over the township waterworks with lake water completely replacing the well water in off-peak periods. The 4 municipal wells produced 3.5 mgd in 1954 and 1955 peak demand periods. Tables present information collected on 1,020 old wells, 69 new wells, and 64 test holes. A geological map, scale 1 in./1/2 mi, a well location map (same scale), and a plate each of geologic sections and hydrographs are included. The surficial material is glacial till interlayered with sand and gravel deposits. To produce much water, a well must be in a sand or gravel layer; several such wells yield over 1000 gpm. All the high capacity wells are in gravel deposits in buried valleys. A well in the shale bedrock may yield as much as 3 gpm. Deep drilling increases the risk of obtaining salty water. Chemical analyses from 11 wells show hard water with up to 366 ppm Na in the deeper bedrock wells.
W68-00516

HYDROGEOLOGIC DATA FOR THE LOWER THAMES AND SOUTHEASTERN COASTAL RIVER BASINS, CONNECTICUT.,
US Geological Survey.
Michael A. Cervione, Jr., I. G. Grossman, and Chester E. Thomas, Jr.
Conn Water Resources Bull No 16, 65 p, 1968. 1 fig, 1 plate, 10 tab, 15 ref.

Descriptors: *Groundwater, Water wells, *Hydrologic data, Chemical analysis, Water quality, Water levels, *Data collections, Temperature, Conductivity, *Streamflow, Low flow, Wells, Water, Streams, Discharge measurement, Connecticut, Gaging stations, Stream gages, Springs.
Identifiers: Specific conductance, *Well data, *Chemical analyses (Water), Water-level measurements, Drillers' logs, Thames River.

Hydrologic and geologic data covering the water resources of the Lower Thames and southeastern coastal rivers of Connecticut are presented. The data resulted from an investigation by the U.S. Geological Survey on cooperation with the Connecticut Water Resources Commission and are presented in tabular form to accompany a separately published interpretive report. Groundwater data include records of about 740 wells, 5 springs, and logs of 229 wells and test holes. Partial records of 33 gaging stations, each having from 3 to 17 discharge measurements and from 6 to 46 stage measurements made from 1960 to 1964, are tabulated. Chemical analysis data include silica, iron, manganese, calcium, magnesium, sodium, potassium, bicarbonate sulfate, chloride, fluoride, nitrate, phosphate, TDS, dissolved oxygen, ABS, and turbidity. Data collection sites are shown on a topographic map, scale 1:48,000.
W68-00526

GEOLOGY AND GROUND-WATER OCCURRENCE IN SOUTHEASTERN MCKINLEY COUNTY, NEW MEXICO,
US Geological Survey.
James B. Cooper, and Edward C. John.
N Mex State Eng Tech Rep 35, 108 p, 1968. 7 fig, 2 plate, 5 tab, 58 ref.

Descriptors: *Groundwater, Groundwater recharge, Aquifers, *Water quality, Natural recharge, Discharge (Water), Radium radiosotopes, Stratigraphy, Radioactivity, Mine water, Wells, Springs, Geologic control, Water users, *New Mexico.
Identifiers: *McKinley County, Uranium mine discharge, Well sampling, Well logs, Potential water supply, Conductance.

Geologic conditions and the general availability and chemical quality of groundwaters in southeastern McKinley County, New Mexico are described with particular emphasis on areas where large bodies of uranium ores are present. The principal aquifers, their areal extent, and their areas of recharge and discharge are discussed. Water wells are furnished by 16 distinct aquifers, mostly artesian, in rocks that range in age from Permian to Quaternary. Yields of 300 gpm are obtained from wells that tap aquifers in the Glorietta Sandstone and San Andres Limestone. Groundwater in adequate quantities and of usable quality for stock and domestic use is available throughout southeastern McKinley County. Uranium mines discharge millions of gallons of water; some of the water is used in the mills, but most of it is pumped to waste. Groundwater associated with the uranium deposits is slightly radioactive. Several samples from mines or wells contained concentrations of radium somewhat above the recommended maximum limit for drinking water. Recharge to aquifers in southeastern McKinley County is mainly from precipitation on outcrops of the rocks and from water along fault zones.
W68-00527

MANAGEMENT OF GROUND WATER AQUIFERS,
Leggette, Brashears and Graham, New York, NY.
Jack B. Graham.
J Amer Water Works Ass, Vol 60, No 6, pp 640-644, June 1968. 5 p.

Descriptors: *Aquifers, *Administration, *Water management (Applied), Aquifer characteristics, Hydrologic aspects, Groundwater movement, Waste water disposal, Land subsidence, Water reuse, Saline water, Water utilization, Detergents, Input-output analysis, Recharge, Sewage treatment.
Identifiers: *Aquifer management Disposal wells, Water quality problems, Aquifer potential, Underground system.

An aquifer is defined, administrative agencies are described, and hydrogeologic data requirements are outlined for effective aquifer management. Water quality problems are outlined in relation to aquifer management, particularly artificial recharging and waste disposal by wells. The degree to which future water administration is undertaken will be dictated by need. Benefits of essentially complete aquifer management will be cheaper than demineralization of brackish water or long distance importation. Complete management is defined as including stringent controls over water pollution, regulation of withdrawal, widespread facilities for artificial recharge, use of excess surface sources including treated sewage, and utilization of slightly mineralized groundwater that is undeveloped because of its quality. Full utilization of aquifers, consistent with the hydrologic limitations of the system, is encouraged.
W68-00528

GILBERT-STAATEN RIVERS GROUNDWATER INVESTIGATION--HYDROGEOLOGICAL REPORT OF THE GILBERT 'DELTA' AREA,
Geological Survey of Queensland, Brisbane, Australia.
K. R. Warner.
Geol Surv of Queensland Rep No 24, 18 p, 1968. 4 fig, 1 map, 10 tab, 61 ref, 2 append.

Descriptors: *Groundwater, *Hydrology, Underflow, Water quality, Boreholes, Water supply, Geomorphology, Deltas, Irrigation, River beds, Channels, Fluorides, Water utilization, Salinity.
Identifiers: *Australia, Gilbert-Staaten Rivers, Water bore records, Geologic section.

A hydrogeological investigation was initiated in 1965 to determine the availability of underground water for possible irrigation in the Gilbert and Staaten River area. Groundwater suitable for irrigation was not found. Supplies suitable for domestic use are limited, the best prospects being the underflow of small creeks and fossil sand dunes near the coast. Groundwater supplies suitable for stock use are available in many parts of the Tertiary Lynd Formation close to local intake areas, especially in the eastern part of the area mapped; but the proportion of successful bores is not likely to be greater than 50%. A better success rate for wells may be obtained if bores are sited close to sandy creeks of intermittent flow, or large sandy ridges indicative of former stream courses. Artesian flowing wells can be obtained at depths of more than 2,000 ft in Mesozoic sandstone, but high fluoride content renders the water unsuitable for human or stock drinking. Alluvium in the upstream reaches of the Gulf rivers could provide large supplies of good quality water. Tables of well data, water analyses, and a geologic map in color are given.
W68-00531

GROUND-WATER RESOURCES DATA OF CHARLOTTE, DE SOTO, AND HARDEE COUNTIES, FLORIDA,
U S Geological Survey.
M. I. Kaufman, and N. P. Dion.
Florida Div of Geol Inform Circ, No 53, 24 p, 1968. 4 fig, 4 tab, 8 ref.

Descriptors: *Groundwater, *Water wells, Hydrologic data, Aquifers, *Water quality, *Chemical analysis, Water levels, Data collections, Subsurface waters, Water yield, Conductivity, Temperature, Florida.
Identifiers: *Well data, Chemical analyses (Water), Water-level measurements, Specific conductance.

In order to plan the future water-resource development of Charlotte, De Soto, and Hardee Counties, Florida, the U. S. Geological Survey, in cooperation with the Peace River Basin Board of the Southwest Florida Water Management District, began a continuing hydrologic data collection in July 1963. The data presented constitute the basis for a Map Series report. Additional data, including records of wells and chemical analyses, are also included. Locations of the inventoried wells are shown on a map. The relation between total dissolved solids content and specific conductance of the waters is shown graphically. Well inventory data and chemical analysis reports are presented in 2 tables.
W68-00542

GEOLOGY OF APACHE MOUNTAINS, TRANS-PECOS TEXAS,
Texas Univ., Department of Geology, and Bureau of Economic Geology, Austin, Tex.
John W. Wood.
Univ of Tex, Austin, Bur of Econ Geol Quadrangle Map No 35, 32 p, 1968. 2 tab, 94 ref.

Descriptors: *Water resources, *Texas, Subsurface waters, Water supply, *Groundwater, Water utilization, *Aquifers, Domestic water, Stock water, Municipal water, Springs, Intermittent streams, Alluvium, Irrigation wells, Dissolved solids, Surface waters.
Identifiers: Apache Mountains, Texas, Trans-Pecos Texas, Alluvial water, Kent, Texas, Bolson fill, Sandstone aquifers.

The occurrence of groundwater, the most important resource of Trans-Pecos Texas, is described. Surface supplies are scarce; a little water is stored in numerous earthen stock tanks, which are frequently dry because of scanty rainfall. All streams are intermittent. Springs are unknown in

he Apache Mountains. Wells provide domestic nd stock water, mostly from the Cox sandstone, he principal aquifer. Around the western margin f the Apaches 57 wells ranging in production from 00 to 2,450 gpm in alluvium and bolson fill pro- ide enough water for irrigation. Their average epth is about 450 ft. Dissolved solids range from 13 to 2,900 ppm. Wells north of the Apache ange are from 200 to 500 ft. deep, and are robably in the Cox sandstone. The area around ent imports most of its water from the Davis ountains.
W68-00556

NNUAL REPORT ON GROUND WATER IN RIZONA, SPRING 1966 TO SPRING 1967,
eological Survey.
. L. Cox.
riz State Land Dep Water-Resources Rep, No 36, 3 p, May 1968. 30 fig, 1 tab.

escriptors: *Groundwater, Water wells, Hydrologic data, Aquifers, *Water levels, Water able, *Data collections, Water level fluctuations, Water sources, *Arizona, Artesian wells, Observa- ion wells, Safe yield, Potentiometric level.
dentifiers: Annual groundwater report, Arizona, Water level measurements.

ata on Arizona's groundwater supply are com- iled. Graphs show water levels in selected wells nd estimated annual pumpage in most developed reas. Maps show depth to water in selected wells n spring 1967, change in water level in selected ells from 1962-67, potential well production by reas, and areas in which groundwater data are vailable. Estimated annual groundwater pumpage or the entire period of record is tabulated. The urrent status of groundwater programs for the tate is summarized and 18 current publications of he Arizona District are listed. The current ground- ater conditions of the State are listed by topo- raphic provinces.
W68-00568

YDROLOGIC RECONNAISSANCE OF SKULL ALLEY, TOOELE COUNTY, UTAH,
eological Survey.
. W. Hood, and K. M. Waddell.
tah Dep of Natur Resources Tech Publication No 8, 57 p, 1968. 8 fig, 2 plate, 11 tab, 35 ref.

escriptors: *Hydrogeology, *Utah, Precipitation (Atmospheric), Water quality, Surface waters, roundwater, Evapotranspiration, Natural echarge, Watersheds (Basins), Springs, Wells, eologic control, Water analysis, Geomorphology, eather data, Irrigation, Land use, Water utiliza- ion.
dentifiers: *Skull Valley, Tooele County, Con- olidated rocks, Potential water supply.

he source, movement, chemical quality, and isposition of water in Skull Valley are described. onsolidated rocks in the valley are the framework f the 880-sq-mi drainage basin; they outcrop in he valley and uplands, and underlie the surface at epths controlled by the geologic structure. Source f water is precipitation on the mountains. Esti- ated potential long-term average annual runoff rom the uplands is 32,000 acre-ft, a small part of hich flows out of the valley; the rest becomes echarge or is lost through evapotranspiration. The verage annual aquifer recharge and discharge is rom 30,000 to 50,000 acre-ft. Evapotranspiration ccounts for 85% of the groundwater discharge. stimated perennial yield of groundwater is up to 0,000 acre-ft. Recoverable stored water in the top 00 ft of saturated unconsolidated rocks is about .3 million acre-ft, and 1 million of this is con- idered chemically suitable for irrigation and omestic uses. Quality of the water limits potential alley development; issolved-solids content ranges rom 98 to 17,200 ppm. Saline water is found north f losepa and in parts of the valley south of losepa. ood quality water underlies the alluvial apron ordering the Stansbury and Onaqui Mountains, he greatest recharge areas.
W68-00573

WATER LAW IN MICHIGAN--SECTIONS III-IV,
Theodore Lauer, Dominic King, and Wilbert L. Ziegler.
In Water Resources and the Law, pp 522-531, 1958. Michigan Univ. Law School, Ann Arbor, 10 p, 31 ref (see W68-00581).

Descriptors: *Michigan, *Groundwater, Percolating water, Underground streams, Reasonable use, Water pollution, Consumptive use, Legislation, Judicial decisions, Administrative agencies, *Water law.
Identifiers: English rule, Water Resources Commission.

The legal aspect of ground water centers on consumptive use and pollution. Virtually all uses of ground water are consumptive in nature. Legally, ground water is divided into two categories: underground streams and percolating, or diffused, ground water. Rules governing the use of water from surface watercourses apply to underground streams, although there is a presumption in favor of ground water being of a diffused nature. Of the two rules governing the use of percolating ground water, the English common law rule and the American, or reasonable use rule, Michigan has adopted the latter. As to pollution of ground water, the Michigan legislature has enacted into law the reasonable use standard. The Water Resources Commission has power to abate ground water pollution caused by waste disposal that is unreasonable and against public interest. In conclusion, it is pointed out that although the purpose of the study is to set forth present legal principles governing water use, this does not mean that there are not deficiencies in the law. Some of the outstanding ones are pointed out.
W68-00603

HART V D'AGOSTINI (REASONABLE USE IN PUMPING OF SUBSURFACE WATER).

7 Mich App 319, 151 N W 2d 826-828 (1967).

Descriptors: *Subsurface waters, Water sources, Wells, Water wells, *Pumping, Percolating water, *Reasonable use, Beneficial purpose, Michigan.

The defendants constructed a sanitary sewer trunk line on a public utility easement in close proximity to the plaintiff's home. Pumping of water through 12-foot wells driven along the trunk line was necessary to lower the water, so the construction could proceed. This pumping of the water out of the area of the sewer construction caused the plaintiff's well to go temporarily dry. The plaintiff succeeded in his suit for damages in the trial court, but the Court of Appeals of Michigan reversed. The reviewal was based on the premise that liability for intentional interference with the subterranean water supply of a neighbor depends on whether the causative activity was unreasonable. The court concluded that the activity was not unreasonable, but reasonable in the sense that the improvement and development of the public utility easement, which would benefit all the surrounding homes, required such steps.
W68-00612

4C. Effects on Water OF Man6s Non-Water Activities

EFFECTS OF URBANIZATION,
City of Philadelphia, Pa.
Samuel S. Baxter.
Water Resources Bull, Vol 4, No 1, pp 51-56, Mar 1968. 6 p.

Descriptors: *Community development, *Urbanization, Taxes, Social aspects, Urban renewal, Land use, Drainage systems, Management, Water supply, Waste disposal, Pollution abatement, Flooding, Multiple-purpose projects, Legislation, Decision making, Technology, *Public health, Communication, *Water reuse.
Identifiers: *Urban centers, Political factors, Rate structures, *Storm sewers, Duplicate systems, Management research.

Reviewed are existing urban problems and the types of remedial research needed. Particular stress is placed on economic, social, and political factors involved. Cities are requiring larger taxes and service charges because of increasing demands and needs for all public services. This, coupled with a reluctance to pay for the services, is causing urban groups to turn more and more to Federal sources and less to State governments for assistance. Shortages and failure in water supply, needed water pollution control, flooding caused by undersized storm sewers, and fire losses resulting from low water pressures are foremost problems; these are complicated by growing urbanization. Increased Federal funding with controls, particularly under various water quality acts, has lessened local and state control of problems. Technical research must be accompanied by improved procedures in management and finance. It is concluded that although basic research may provide a real breakthrough in water knowledge, there is need to apply more fully what is already known and to meet the growing problems as they occur.
W68-00333

THE GREAT CHANGES IN THE MACROBENTHOS OF LAKE VARESE BETWEENItaly. the period 1957-1962,
Instituto Italiano di Idrobiologia, Verbania Pallanza, Italy.
G. Bonomi.
Acqua Industriale, 21, pp 1-4, 1962. 5 p.

Descriptors: *Eutrophication, *Lakes, Lake morphometry, Benthic fauna, *Animal populations, Oligochaetes, Midges, Diptera, Time, Industrial wastes, *Sewage, Domestic wastes, On-site data collections.
Identifiers: Italy, Varese Lake.

Lake Varese (14.95 sq km, max depth 25.7 m, mean depth 10.7 m, and vol 162,400,000 cu m), located in northern Italy, underwent certain major changes in its benthic fauna between 1957 and 1962. By comparing the numbers of certain species in and the biomass of the benthic fauna, Bonomi noted that, during this interval, Tendipes anthracinus had completely disappeared, the oligochaete population had been reduced, and the Chaoborus flavicana population had shown a mild increase from the time of the first sampling in 1957 until the sampling in 1962. These changes were attributed to an increase of human and industrial sewage. More data will be needed for a follow-up study of this lake.
W68-00464

FEDERAL POWER COMMISSION CONTROL OVER RIVER BASIN DEVELOPMENT,
Va L Rev Assoc, Charlottesville.

Va L Rev, Vol 51, No 4, pp 663-685, May 1965. 23 p, 118 ref.

Descriptors: *Federal Power Act, Federal government, *River basin development, *Hydroelectric project licensing, Navigation, Watersheds (Basins), Fish recreation facilities, Pumped storage, Water storage, Resource allocation, Multi-purpose projects, Wild River Act, Federal-state water rights conflict, Administrative agencies, Fish barriers.

The Federal Power Act of 1935, is reviewed in light of its past failures and new opportunities for effective regulation. The previous inability of the FPC to secure an adequate jurisdictional foundation was cited as the primary reason for its inability to provide comprehensive river basin control. However, recent interpretation of 'navigable waters' and 'ef-

fects on commerce' have substantially broadened the FPC's jurisdiction and should permit more meaningful license terms and conditions. A review of the FPC's licensing operations over the past 15 years reveals that it has consistently granted licenses where large power benefits were to be derived and has sought to minimize harm to the nonpower interests through use of license conditions. This technique is criticized on grounds that the policy of preserving some wilderness is ultimately irreconcilable with the policy of developing electric power at the lowest possible cost; and that attempts to design hydroelectric facilities to minimize their effect on unspoiled areas do not provide adequate protection for conservationists. Recommendation is made for conservationists to support proposals, such as the Wild River Act, to set aside specific streams on which no commercial development would be allowed.
W68-00605

HAISCH V SOUTHAVEN LAND CO (LEGAL ASPECTS OF URBANIZATION ON WATER YIELDS AND FLOW RATES).
274 F Supp 392 (N D Miss 1967).

Descriptors: *Mississippi, *Drainage systems, Drainage practices, Legal aspects, Judicial decisions, Reasonable use, Surface waters, Surface runoff, Stream flow.

Under Mississippi law, the defendant as an upper riparian owner had the right to improve its lands by straightening and improving water courses to such width and depth as to properly drain its lands, although the result of the improvements would be to increase the volume and speed of the flow of these streams onto the lands of the plaintiff. The development of land by the defendant in a metropolitan area as a residential-type subdivision is a reasonable use of the land, and should have been anticipated by the plaintiff. Any and all damages done to plaintiff's property by reason of defendant's undertakings are losses which do not give rise to an action for damages.
W68-00629

4D. Watershed Protection

WHAT FORESTS MEAN TO SOIL AND WATER.
Tennessee Valley Authority, Knoxville.

Tennessee Conservationist, Vol 34, No 3, pp 13-14, Mar 1968. 2 p, 5 photo.

Descriptors: *Erosion control, *Reforestation, Loblolly pine, Soil loss, Water yield, Runoff, Peak discharge, Timber management, *Sediment traps, Pulpwood, Water bars, Filter strip.
Identifiers: *Alluvial soils, West Tennessee, Pine plantations, Gross return.

Following a five-year calibration period on an 88-acre experimental watershed in west Tennessee, erosion control measures and reforestation were initiated. Changes in watershed hydrologic characteristics were rapid and dramatic. A second phase of the study measuring the hydrologic effects of timber management practices began seventeen years later with the establishment of a permanent system of logging trails and the subsequent removal of pulpwood three years later.
W68-00499

THINNING AN EXPERIMENTAL WATERSHED,
Tennessee Valley Authority, Knoxville.
William H. Nussbaumer.
Forest Farmer, Vol 27, No 9, pp 10-11, 17, May 1968. 3 p, 5 photo.

Descriptors: *Erosion control, *Reforestation, Loblolly pine, Soil loss, Water yield, Runoff, Peak discharge, Timber management, *Sediment traps, Pulpwood, Water bars, Filter strip.
Identifiers: *Alluvial soils, Western Tennessee, Pine plantations, Gross return.

In spring 1946 after five years of calibration, an 88-acre watershed in western Tennessee, typical of large areas of severely eroded alluvial soils in that region, was brought back into production through erosion control measures and reforestation. Hydrologic changes were rapid and dramatic. After five years: (1) Surface runoff was reduced about 34 percent. (2) Peak discharges dropped 75 percent. (3) Subsurface flow increased. (4) Soil loss was cut by 90 percent, from 24.2 to 2.5 tons per acre per year. Improvement continued at a slower rate over the next ten years with storm runoff recording substantial decreases. By 1960, soil-forest-water relationships were stabilized and the second phase of the study began--measuring the hydrologic effects of normal timber management practices. Two miles of permanent logging trail was completed in 1963, and three years later 494 cords of pulpwood were harvested from some 70 acres. A reinventory of the residual stand shows that if the present timber is left as growing stock, an estimated yield of 2.5 million board feet of sawtimber and 2,400 cords of pulpwood can be expected over the next 25 years. The total gross return for the 45-year rotation of the planted trees should be about $60,000, an average of $18 per acre per year.
W68-00500

TDS AND SPECIFIC GRAVITY IN GROUND WATERS,
Indian Administration Service, Gauhati, Assam, India, and Lucknow University, Lucknow, India.
S. K. Agnihotri, and D. N. Tewari.
J Amer Water Works Ass, Vol 60, No 6, pp 733-737, June 1968. 5 p, 4 tab, 11 ref.

Descriptors: *Dissolved solids, Electrolytes, *Ionization, *Specific gravity, *Analytical techniques, Chemical properties, Water chemistry, Ground water.
Identifiers: *Dilute solutions, Hydrochemical facies, Anions, Electrostriction.

Determination of specific gravity and total dissolved solids (TDS) in a number of surface and subsurface water samples with high TDS showed a loose relationship between these parameters. Study of solutions of various salts present in natural waters showed no common factor relating TDS and specific gravity. There was, however, a common factor for waters of similar hydrochemical facies. The formula TDS = (Sp gr - 1)f, when f is an empirical common factor, was found to yield values of f between 100 and 150. Once f has been determined for water of a hydrochemical facies to be studied, the relationship given can be used to calculate approximate TDS quickly in the field.
W68-00539

THE EFFECT OF FIRE ON GEOMORPHIC PROCESSES IN THE SAN GABRIEL MOUNTAINS, CALIFORNIA,
Wyoming Univ., Laramie.
Donald O. Doehring.
Univ of Wyo Contrib to Geol, Vol 7, No 1, pp 43-65, Winter 1968. 23 p, 12 fig, 5 plate, 3 tab, 40 ref.

Descriptors: *Erosion, *Accelerated erosion, Debris avalanches, Degradation (Stream), Landslides, Mass wasting, Rill erosion, Sheet erosion, Stream erosion, *Burning, Damages, Floods, Geomorphology, Precipitation (Atmospheric), Sedimentation, Storms, California, Runoff.
Identifiers: San Gabriel Range, California, San Dimas Experimental Forest, *Fire-accelerated erosion, Geomorphic processes, Normal erosion.

A detailed study of the accelerated erosion during a 7-yr period following a fire in the San Dimas Experimental Forest in the San Gabriel Mountains showed that the fire-streamflood sequence removed in a short time the equivalent of 40-yr 'normal' erosion. This process is thought to be essential 'non-normal' element in the formation of present landforms, and in a hypothetical century of erosion it would remove an additional 3.0 in. from the hillslopes while 'normal' erosion would remove an additional 1.6 in. There is reason to believe that the fire frequency is approximately 3 burns per century and that fire-accelerated erosion is an integral part of the geomorphic process in the San Gabriel Mountains. The heat of the fires removes soil moisture and cohesiveness so that debris slides can carry the soil into stream channels where higher than normal runoff (due to vegetation removal) carries it away.
W68-00547

SEDIMENTATION IN THE ESTUARY OF THE RIVER CROUCH, ESSEX, ENGLAND,
Fisheries Laboratory, Burnham on Crouch, Essex, England.
R. W. Sheldon.
Limnol and Oceanogr, Vol 13, No 1, pp 72-83, Jan 1968. 12 p, 10 fig, 25 ref.

Descriptors: *Sedimentation, Tides, Currents (Water), Tidal effects, Sands, Silts, Waves (Water), Sediment transport, Erosion, Turbulent flow, Estuaries, Marshes, *Land subsidence, Peat, Compaction, Channels, Embankments, Drowned (Submerged).
Identifiers: *Estuary sedimentation, River Crouch, England, Wave action, Depositional cycle, Ecological conditions.

Distribution of sediments in the River Crouch, Essex, England is described generally. Source of the sediments may be offshore deposits of boulder clay eroded by tidal currents. This eroded material could produce the distribution of sedimentary properties found in the Essex estuaries. It is stated that bottom deposits are composed of 2 distinct particle populations: a fine sand fraction which is believed to be transported near the bottom and a silt fraction derived from suspension. Offshore, in areas exposed to wave action, there are fine sands with very little silt. The proportion of silt increases and the modal diameter of the fine sand fraction decreases towards the head of the estuary. Graphs show size-frequency distributions of suspended matter from the estuary.
W68-00563

05. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification OF Pollutants

WATER POLLUTION FROM LAND RUNOFF,
Agricultural Research Service, US Department of Agriculture.
K. C. Walker, and C. H. Wadleigh.
Plant Food Rev, Vol 14, No 1, pp 2-4, 1968. 3 p, 1 photo.

Descriptors: *Runoff, *Water pollution, Infiltration, Sediments, *Sediment yield, *Nutrients, Eutrophication, Inorganic compounds, Nitrates, Phosphates, Calcium, Magnesium, Fertilizers, Agricultural chemicals, Fishkill, Pesticides, Endrin, Irrigation, Acid mine water.
Identifiers: *Livestock wastes, Runnels, Feedlots, *Land runoff, Manure recycling, Bacterial pollution.

Contributions of agricultural activities to the pollution of runoff is surveyed, and it is found that sediment is by far the most prevalent entity that impairs water quality. Of the average annual precipitation, 30% becomes runoff and less than 1% infiltrates deeply. Sediment yield in the Mississippi basin averages 390 tons annually per sq mi. Large amounts of nutrients are lost with sediments. For example, the load per yr of nitrogen is 500,000 tons; phosphate, 750,000; calcium, 5,400,000;

magnesium, 2,400,000; and livestock wastes, 1.6 billion (1965). Associated wastes brought the annual total to 2 billion tons. Organic waste problems are severe. 50,000 head of beef cattle produce as much waste as 600,000 people; therefore, serious economic and engineering planning is necessary for disposing of manure or for recycling it for fertilizer use. Major fish kills have occurred because of feedlot runoff, which with other farmland runoff contains high nitrates and phosphates. Pesticides usually are present but in low concentrations. Irrigation increases the natural salts content of runoff. Acid mine drainage is a problem in the Ohio River Watershed.
W68-00320

SAMPLING BACTERIA IN A MOUNTAIN STREAM,
Colorado State University, Fort Collins, Colo.
S. H. Kunkle, and J. R. Meiman.
Colo State Univ Hydrol Pap No 28, 27 p, Mar 1968. 25 fig, 14 tab, 13 ref, 1 append.

Descriptors: Indicators, Water pollution, Wastes, *Bacteria, Water pollution sources, *Coliforms, *Streptococcus, *Bioindicators, Sampling, Hydrographs, Statistical methods, Temperature, Cattle, Land use.
Identifiers: *Water pollution indicators, Insolation, Parameters measured, Graphical plots, Variation coefficients.

Pollution-indicating bacteria groups--the coliforms, fecal coliforms, and fecal streptococci--were used to investigate bacteria fluctuations and concentrations below and above a pollution source in a small high-elevation stream in the Colorado Rocky Mountains, 1966-67. The upper of 2 sites sampled as streamflow from an uninhabited forested area, while the lower (1.5 mi downstream) was below a grazed meadow irrigated by the creek. Statistical analysis showed that analytical error is an important source of variation with a coefficient of 0.5 in coliform replicates from one bottle, that there was more day-to-day variation than within a day, and that variability was highest at lowest concentrations. Bacteria counts showed a daily cycle with highest counts in the evening, lowest in the afternoon, and intermediate morning values. Seasonally, the spring high stage had the highest counts at the lower site while counts were highest at low flows at the upper site. The cattle-influenced site always had higher counts than the upper site. Water temperature was inversely related to concentration. Insolation rapidly killed bacteria. Coliform to streptococci ratio was less than 1.0 at the upper site and ranged from 1.70 to 5.45 at the lower.
W68-00332

A REVIEW OF CENTRAL EUROPEAN METHODS FOR THE BIOLOGICAL ESTIMATION OF WATER POLLUTION LEVELS,
Dept. of Zoology, Bonn Univ., Federal Republic of Germany.
Hartmut Bick.
Bull Wld Hlth Organ, Vol 29, pp 401-413, 1963. 13 p.

Descriptors: *Eutrophication, Water pollution, *Water pollution effects, *Ecological distribution, Bioassay, *Water quality, Systematics, Bioindicators, Biological community, Oxygen demand, *Plant physiology, Biochemical oxygen demand, E. coli, Scenedesmus.
Identifiers: Central Europe, Saprobity, Germany.

The author describes two methods used in Central Europe for estimating water-pollution levels by biological means: 1. Direct or ecological methods. -- Water sample is collected and all species present are listed; water quality is then assessed on the basis of occurrence and frequency of indicator organisms or the composition of the biocoenosis. Techniques included are: a. Prantle and Buck. -- S= (summation sxh)/ (summation h), where S=saprobity index, s=degree of saprobity, and h=frequency of occurrence of single species; and b. Kothe. -- species-deficit given as a percentage value. 2. Indirect or physiological methods. -- These methods are used for bioactivity estimates or bacteria counts in which the reactions of particular test species inoculated into the test water serve as a water-quality index. The techniques include: a. Bringmann and Kuhn's index of biomass using E. coli to indicate high pollution and Scenedesmus to show less pollution; b. the well known BOD sub 5 procedure; c. the TTC method for plate counts of bacteria based on the reduction of TTC to red formazan by the reductases of living bacteria; and d. Casper's oxygen-consumption method in which sediment activity is determined by measuring sediment demand for oxygen.
W68-00477

COMPUTER AIDED DESIGN OF WASTE WATER COLLECTION AND TREATMENT SYSTEMS,
University of Michigan.
Rolf A. Deininger.
Annual Progress Report on Project to Office of Water Resources Research, August 1968. 1 p.

Descriptors: Computers, Systems analysis, Automatic plotting, Design of treatment plants, Sewerage systems.

The purpose of this research is to study the use of computers and systems analysis techniques for the design of waste water collection and treatment systems. The following areas are being investigated: (a) the optimal design of sewer systems, (b) the optimal design of waste water treatment plants, (c) conversational design of treatment plants on a time shared computer, and (d) the feasibility of generating equipment. After a thorough literature review progress has been mainly in the area of conversational design of treatment plant, the optimal design of sewer systems, and the generation of construction plans on automatic plotting equipment.
W68-00495

THE FRESHWATER MUSSEL AS A BIOLOGICAL MONITOR OF PESTICIDE CONCENTRATIONS IN A LOTIC ENVIRONMENT,
Michigan State University, Department of Fisheries and Wildlife, East Lansing, Mich.
J. W. Bedford, E. W. Roelofs, and M. J. Zabik.
Limnol and Oceanogr, Vol 13, No 1, pp 118-126, Jan 1968. 9 p, 9 tab, 18 ref.

Descriptors: *Mussels, *Pesticide kinetics, *DDT, Aldrin, Surface waters, Pesticide residues, Monitoring, Rivers, *Water pollution, Environmental gradient, Adsorption, Michigan, Aquatic environment, Bottom sediments.
Identifiers: *Biological pesticide monitor, DDT metabolites, Red Cedar River, Methoxychlor.

Freshwater mussels (2 species) were introduced into the Red Cedar River, Mich, at 6 locations and analyzed for pesticide content following different lengths of time in the river. DDT and its metabolites, TDE and DDE, were found in all mussels analyzed. The concentration of DDT and its metabolites increased significantly in a downstream direction and increased significantly with time before reaching a plateau. Methoxychlor was found in mussels on 2 dates of retrieval from the river but was not found before or after these dates. Mussels collected from the upper portion of the study area contained small concentrations of DDT and its metabolites. No significant difference in pesticide content occurred between species. The purpose of this investigation was to determine whether the freshwater mussel, a filter feeder, was capable of concentrating the minute pesticide quantities in the water and of reaching an equilibrium that is correlated with the concentration of pesticide in the water. Use of the mussel for pesticide monitoring has an advantage over other methods, particularly in remote areas, and gives a better picture of biological damage than does the carbon adsorption method.
W68-00514

STABLE CARBON ISOTOPE RATIOS AS INDICES OF PETROCHEMICAL POLLUTION OF AQUATIC SYSTEMS,
Texas Univ. Marine Science Institute, Port Aranas, Tex.
John A. Calder, and Patrick L. Parker.
Environ Sci and Technol, Vol 2, No 7, pp 535-539, July 1968. 5 p, 2 fig, 4 tab, 10 ref.

Descriptors: *Water pollution, *Pollutant identification, Water pollution sources, *Indicators, Pollutants, Air pollution, Wastes, Texas, Organic compounds, Canals, *Industrial wastes, *Chemical wastes, Stable isotopes.
Identifiers: *Petrochemical pollution, Houston, Texas, Corpus Christi, Texas, Carbon isotopes (Stable), Dissolved organic matter.

Variations in the carbon-12/carbon-13 ratio of dissolved and particulate organic matter from several water bodies for both natural systems and those polluted with organic chemicals, have been investigated. Delta carbon-13 from natural systems ranges from -14 to -23 relative to reference material No. 20 of the National Bureau of Standards; in petrochemical products and effluents it ranges from -25 to -49. The delta carbon-13 value of dissolved organic matter of 15 samples from the Houston, Texas Ship Channel was measured. Calculations based on these data suggest that the carbon-13/carbon-14 ratio of dissolved organic matter may be used as a quantitative index of petrochemical pollution.
W68-00557

5B. Sources of Pollution

ENVIRONMENTAL EFFECTS OF OVERBOARD SPOIL DISPOSAL,
Maryland Univ, Solomon, Md.
Robert B. Biggs.
ASCE Proc, J of Sanit Eng, Vol 94, No SA3, Pap 5979, pp 477-487, June 1968. 12 p, 9 fig, 1 ref, 1 append.

Descriptors: *Dredging, *Environmental effects, *Sediments, *Water pollution sources, Channels, Navigation, Turbidity, Salinity, Estuarine environment, Temperature, Clays, Currents (Water), Velocity, Nutrients, Intertidal areas, Buoys, Sampling, Bays, Spoil banks, *Bottom sediments, Maryland.
Identifiers: *Wind-wave energy, *Nutrient enrichment, Chesapeake Bay, Ambient levels.

Navigation channel improvements along a 14-km reach in upper Chesapeake Bay required that 4.5 x 10 to 6th power cu m of silt and clay be dredged, and the spoil deposited in shallow water 1000 m west of the dredging site. Biological and geological studies were performed on a 3-km test section of the planned work, involving 1.3 x 10 to 6th power cu m of spoil deposited in shallow water (about 4 m deep). Bi-weekly cruises were made to measure total material in suspension, temperature, salinity, bottom sediment characteristics, and current velocity patterns in the anticipated area of effect. During the actual spoil disposal, continuous determinations of the distribution of suspended sediment were made and compared with 'background' levels. Results indicate that measurable quantities of suspended sediment extended as far as 4 km from the disposal site, that the spoil on the bottom did not remain within limits of the disposal area, and that dissolved nutrients contained in the spoil sediment pore-water were probably released to the environment.
W68-00325

MANMADE CONTAMINATION HAZARDS,
California Univ, Sanitary Engineering Research Laboratory, Berkeley, Calif.
P. H. McGauhey.
Ground Water, Vol 6, No 3, pp 10-13, May-June 1968. 4 p, 4 ref.

Descriptors: *Groundwater, Surface-groundwater relationships, *Waste water disposal, Biodegrada-

tion, Garbage dumps, Landfills, Municipal wastes, Chemical wastes, Farm wastes, Industrial wastes, Organic wastes, *Dissolved solids, Filtration, Nitrates, Fertilizers, Decomposing organic matter.
Identifiers: *Groundwater contamination, Soil filtration, Dissolved organic materials, *Manmade pollutant hazards.

Hazards to groundwater which result from addition of manmade wastes to the natural infiltration system are reviewed. They include waste from man's life processes, industrial and commercial activity, and use of water and agricultural chemicals. Experiments show that particles including bacteria and viruses generally do not move more than a few hundred ft in soil. Dissolved products of biodegradation of wastes move more freely and reach groundwater bodies. These products are generally the same as natural constituents of water so their effect is to increase concentrations of salts already present. The chemical industry may add metal ions, phenols, tars, brines, and exotic organic compounds. Agriculture may enrich water with dissolved soil constituents, nutrients, and pesticide residues. Leaching from solid-waste landfills is possible and might involve any chemicals, oils, iron, and various earth constituents. The most serious contamination hazard in groundwater is the increase of dissolved solids to levels less favorable to beneficial use.
W68-00341

OPTIMIZING SAMPLING INTERVALS IN TIDAL ESTUARIES,
FWPCA, Cincinnati, Ohio.
Charles G. Gunnerson.
American Society of Civil Engineers, Sanitary Engineering Division Journal, Vol 92, No SA2, Paper 4799, pp 103-125, April 1966. 23 p, 11 fig, 5 tab, 13 ref, 2 append.

Descriptors: Operations research, *Computer programs, Digital computer, Dissolved oxygen, *Time series analysis, Tidal waters, Statistics, Automation, E. Coli.
Identifiers: Conductivity data, *Spectral analysis, Potomac Estuary, Raritan Bay.

Spectral analyses of dissolved oxygen and conductivity data in a tidal estuary were performed to determine the quantity of data needed to estimate the mean, and maximum and minimum values. Actual continuously recorded data from the Potomac Estuary and the Raritan Bay were used. It was concluded that: (1) sampling should be performed at more than one depth; and (2) collecting data at six or twelve-minute-intervals yields the same amount of statistical information as data collected at two-hour-intervals. Coliform data for inland waters was also examined. As a dominant source of pollution was approached, it was concluded that a shorter sampling interval for coliform data is required. The arithmetic of power spectrum analysis was reviewed in a separate appendix.
W68-00394

FIRST KINGSTON CORP V THOMPSON (LAKE CONTAMINATION BY POLLUTION FROM UPPER WATERSHED AREA).

233 Ga 6, 152 SE 2d 837-839, (1967).

Descriptors: *Riparian rights, Riparian land, *Georgia, Judicial decisions, *Water pollution, Streams, Natural flow doctrine, Drainage, Drainage patterns (Geologic), *Surface runoff, Water law, Reasonable use, Damages.
Identifiers: *Injunction, Continuing trespass, *Remedies (Legal aspects).

This was an action for a money judgment and an injunction by a lower riparian owner of a small lake against the developer of an upper watershed area. Plaintiff alleged continuing trespass by contaminated water and various negligent acts of the defendant in clearing the area, grading the streets, improper installation of septic tanks and other sewage facilities, and moving a streambed which flowed across the property; all of which caused a more rapid runoff and contamination of the lake, destroying scenic beauty and fishing. Defendants filed a general demurrer. The general rule is that one land proprietor has no right to concentrate, collect and discharge surface water by artificial means upon a lower proprietor in a manner different from that in which the water would normally be received by the lower estate. The acts of negligence, continuing trespass, and nuisance set out in the complaint state a cause of action, hence the complaint is not subject to a general demurrer.
W68-00422

BIOLOGICAL ZONES IN A POLLUTED STREAM,
FWPCA, Cincinnati, Ohio.
F. J. Brinley.
Biological studies, Ohio River pollution survey I; Sewage Wks J, Vol 14, pp 147-152, 1942. 5 p.

Descriptors: *Eutrophication, Stream pollution, *Dominant organisms, Plankton, Dissolved oxygen, Protozoa, Carp, Buffalo fishes, Cyanophyta, Diurnal distribution, Chlorophyta, Suckers, Sewage, Catfishes, Forage fish, *Systematics, Diatoms, *Aquatic populations, Fish populations, Plant populations.

The author divides streams into zones that delineate destruction and recovery of stream conditions following a sewage discharge. A polluted stream may be divided into 5 zones: Zone I -- high bacterial action; low dissolved oxygen (not over 3 mg/1); plankton volume variable but principally composed of ciliated protozoa (Class II); carp and buffalo are the only fish. Zone II -- dissolved oxygen 3-5 mg/1; plankton volume higher than in Zone I, with an increased number of chlorophyll-bearing flagellates, but still composed largely of Class II organisms; cyanophytes abundant. Zone III -- dissolved oxygen above 5 mg/1, often super-saturated in daytime, and subject to diurnal variation; plankton over 1 mg/1, usually several mg/1, largely chlorophytes; fish are varied and abundant, including market fish. Zone IV -- dissolved oxygen above 5 mg/1 and about at saturation; plankton between 0.3 and 1 mg/1, Class II forms scarce; game and forage fish predominate. Zone V -- dissolved oxygen near saturation; plankton less than 1 mg/1, consisting mostly of Class I forms; fish are comparatively scarce, and are mainly game fish.
W68-00482

PLANKTON ALGAE AS INDICATORS OF THE SANITARY CONDITION OF A STREAM,
FWPCA, Cincinnati, Ohio.
F. J. Brinley.
Biological studies, Ohio River pollution survey II, Sewage Wks. J, Vol 14, pp 152-159, 1942. 8 p.

Descriptors: *Eutrophication, Plankton, *Algae, Chemical properties, Bacteria, Organic pollutants, *Streams, Euglena, Nutrients, Plant populations, History, Water purification, *Water utilization, Decomposing organic matter, *Stream pollution.
Identifiers: *Domestic water use.

The author compares the population of certain species of planktonic algae with the chemical and bacteriological indices of the deg of organic pollution in a flowing stream. The comparison shows that large numbers of Chrysococcus and Cryptomonas indicate that the decomposition of the organic matter in the stream has been completed by natural processes and the stream may be considered clean but not that it can be put to domestic use without further treatment. Large numbers of Euglena, Trachelomonas and Phacotus indicate that the water upstream is heavily polluted, and that bacteria have changed the organic matter to available plant food to produce a rich medium. The plankton population serves as a better indicator of the history of a stream than it does of the sanitary condition of the stream at any single place. Most waters, even heavily polluted ones, will contain a few of these forms: therefore, their presence does not necessarily indicate purified water nor does their absence indicate a polluted condition.
W68-00483

EXCHANGE OF MATERIALS IN A LAKE AS STUDIED BY THE ADDITION OF RADIO-ACTIVE PHOSPHORUS,
Dalhousie Univ., Halifax, NS; Fisheries Division of Nova Scotia Department of Trade and Industry.
C. C. Coffin, F. R. Hayes, L. H. Jodray, and S. G. Whiteway.
Canad J Res, D, Vol 27, pp 207-222, 1949. 16 p, 14 fig, 1 tab.

Descriptors: *Eutrophication, *Lakes, Lake morphometry, Epilimnion, *Phosphorus radioisotopes, Radioactive techniques, Plankton, Zooplankton, Cranberries, Diatoms, Cyanophytes, Statistics, Aquatic plants, Fresh water fish, Limnology, Sampling, Mosses, Absorption.
Identifiers: *Acid lakes, Test data.

Most of the radioactive phosphorus added to a small, acid bog lake near Halifax, Nova Scotia, was absorbed by the organisms living in the waters above the thermocline; little of it was detected in the bottom waters, and none was found in the bottom sediments. Periodic samplings of the organisms in the lake waters indicated that sphagnum absorbed the isotope in 2 peaks, the first between 4-10 hr and the second at about 3 wk. Because it its short life cycle, Diaptomus (the predominant zooplankter) reached its single peak after about 1 wk. The two native fish, Fundulus and Notemigonus, reached their isotopic peaks in about 2-3 wk. The cranberry, and the leather-leaf reached their peaks in about 4 wk. Sponges, cyanophytes, and the yellow water lily also absorbed measurable amounts of the phosphorus -- 32. Radioactive counts per weight of organisms, as compared with the base count in the water itself, indicated a range from a max of 40,000 times in zooplankton to a minimum of 80 times in the water lily. Statistical data are shown in the numerous graphs. Because of its great quantity, sphagnum absorbed so much of the phosphorus that fertilization of the water to promote fish growth does not appear to be practical.
W68-00486

CHARACTERISTICS OF INTERFACE FLOW IN SUBSURFACE DISPOSAL SYSTEMS,
Michigan Technological University.
Henry S. Santeford.
A Master's Thesis by Carl O. Gast, 1968, Michigan Technological Univ. Library, 126 pp. Fig. 39; tab 3, ref. 16, Append. 2.

Descriptors: *Septic tanks, *Soil disposal fields, Earth water interfaces, Soil water movement, Porosity, Sewage disposal.

A section of a septic tank drain field was constructed and tested under conditions simulating the conventional and the dosing chamber. Distribution of effluent along the length of the trench soil interface was studied. The effect of physical clogging, using bentonite as a clogging agent, also was investigated. The test section consisted of a 2 ft. x 2 ft. x 24 ft. long box containing a standard trench placed in graded sand. Discharges from this section were measured at one foot intervals along the length of the section. Piezometer readings gave the depth of water at one foot intervals along the trench. Conclusions were: (1) For the conventional system using standard products for the distributor, the effluent was distributed over at most 7 feet of the trench. (2) For dosing chamber tests using dose volumes recommended by P.H.S., a distinct unbalance in the distribution resulted. (3) Uniform distribution could be obtained using a dose volume of approximately 200% of the inside volume of the distributor. (4) Physical clogging tests showed the conventional system outlasting the dosing system by approximately 30%. This condition was proven mathematically and logically. (5) A level trench

bottom would provide for maximum utilization of the field regardless of flow type or slope of distributor pipe.
W68-00493

THE MICROBIOLOGY OF GROUND WATER RECHARGE,
Mississippi State Univ., State College, Miss.
Lewis R. Brown, Robert G. Tischer, and Joe R. Broome.
Completion Report to the Office of Water Resources Research, Department of the Interior, June 1968, 44 p.

Descriptors: Ground water recharge, Microorganisms, Indigenous microflora.

The objectives of this investigation were (1) to follow the changes in microflora which occur in an aquifer which is recharged naturally at the outcrop to a point approximately 50 miles away from the outcrop, and from which drinking water supplies are currently being drawn, (2) to correlate changes in microflora with changes in chemical composition of the water, (3) to isolate and identify the indigenous microflora of this aquifer and (4) to determine the effect of various organic and inorganic materials on this indigenous microflora. The aquifer sutdied in this investigation was the Gordo sand of the Tuscaloosa formation. The wells tested varied from a depth of 50 feet at the outcrop to 1500 feet at State College, Mississippi. The concentration of various types of organisms in the aquifer decreased with increasing distance from the outcrop. This was substantiated by the negative slope of the line derived in the enumeration data. A multiple regression analysis was used in preparing these slopes. There was no apparent correlation between the concentration or type of microorganisms and the chemical constituents in the waters of the Gordo aquifer. Pseudomonads were found to be ubiquitous in the well waters. Brevibacteria were found in the first 35 miles of the sands, while streptococci and coliforms were removed in the first 30 miles. The indigenous microflora was found to give no growth on filtered treated sewage but treated sewage with protein, carbohydrates, or sodium lauryl sulfate showed heavy growth and obnoxious odors were produced. Slime producing bacteria were apparently the organisms responsible for this growth.
W68-00503

ROLE OF SURFACE ACIDITY IN THE ADSORPTION OF ORGANIC POLLUTANTS ON THE SURFACE OF CARBON,
Lehigh University.
R. W. Coughlin, and F. S. Ezra.
Environmental Science And Technology 2, pp 291-297 (April 1968).

Descriptors: Activated carbon, Adsorption, Water purification, Surface oxides.
Identifiers: Functional groups, Surface oxides.

Changes in adsorptive capacity of carbon adsorbents result from alteration of the carbon surface by chemical treatment, particularly with respect to formation and removal of acidic oxides. Increased concentration os surface oxides on carbon greatly reduces the amount of phenol and nitrobenzene that can be adsorbed from dilute aqueous solution of these compounds. In the case of phenol, adsorption from aqueous solutions of higher concentration does not appear to be strongly affected by the presence or absence of acidic chemisorbed oxygen on the surface of the carbon adsorbent. This is interpreted in terms of a two-step adsorption isotherm for phenol on carbon. Alteration of the carbon surface by oxidation and reduction appears to be reversible to a large extent, as evidenced by measurements of both surface acidity and adsorptive capacity.
W68-00508

MICROBIOLOGY OF ANEROBIC SLUDGE,
University of North Carolina, Chapel Hill.
Robert A. Mah.
Dept. of Interior, Federal Water Pollution Control Administration Grant Number 5 RO1 WP00921-03, March, 1968, 8 p, 3 ref.

Descriptors: *Anaerobic bacteria, Anaerobic conditions, *Anaerobic digestion, *Sludge digestion, Methane bacteria, Sewage bacteria.
Identifiers: *Non-methanogenic sludge bacteria, Bacteroides, Anaerobic sludge, *Sludge methane fermentation.

An investigation of the sludge fermentation was initiated to determine the significance of non-methanogenic anaerobic bacteria with regard to their contribution to the degradation of organic compounds to form volatile acids and other intermediates used by methane organisms. Viable colony counts of such non-methanogenic anaerobic bacteria disclosed numbers equivalent to current reports for methanogenic bacteria. Previous investigators reported numbers as high as 10 superscript 7/ml and more often less than this. We found numbers consistently in the range of 10 superscript 8 to 10 superscript 9/ml. Most of the isolates obtained from the highest dilution belong to the Bacteroides group and are being further characterized on various substrates and by end-product analysis of cultures grown on glucose. All isolates were obtained from the highest dilution and are strict anaerobes. No gram-positive organisms were isolated thus far.
W68-00509

MONROE '66' OIL COMPANY V HIGHTOWER (LEGAL DAMAGE FROM SHALLOW WELL POLLUTION BY HYDROCARBONS).

180 So 2d 8-11 (Ct App La 1965).

Descriptors: *Louisiana, *Percolating waters, *Shallow wells, Water wells, Water pollution, Damage, Judicial decisions, Ground water, Path of pollutants, Subsurface flow, Gasoline, Water law, Wells, Ground water movement.
Identifiers: *Damages (Legal aspects), Hydrocarbon pollution.

This was an action on open account for goods sold and delivered by plaintiff to defendant. The correctness of plaintiff's claim was admitted. Defendant reconvened for damages allegedly caused by plaintiff's negligence in installing underground gasoline storage tanks and connecting lines to gas pumps. Defendant owned a cafe which was supplied with water from a shallow well 70 feet away. Plaintiff installed pumps and storage tanks in front of cafe. Within a year defendant's well became polluted by hydrocarbons, and it was found that the tank connections were leaking. As a result of this pollution of the cafe's sole water supply, the health department ordered defendant to close the cafe business. The case deals primarily with the proper measure of damages due the defendant. The court held that defendant was entitled to the cost of a new well plus $100 for the expense and inconvenience of hauling water.
W68-00627

METAL ION CATALYSIS OF OXYGEN TRANSFER REACTIONS. I. VANADIUM CATALYSIS OF THE EPOXIDATION OF CYCLOHEXENE,
Kent State University, Kent, Ohio 44240.
E. S. Gould, R. Hiatt, and K. C. Irwin.
Journal of the American Chemical Society, 90, 4573 (1968).

Descriptors: *Oxidation, *Catalysis, Sulfide, Amine, Unsaturation, *Vanadium, *Epoxidation, *Peroxide, Retardation, Alcohol.

The aim of this study is the investigation of metal catalysis in the oxidation of organic contaminants in water. A number of objectionable contaminants have sulfhydryl, sulfide, or amine linkages, or carbon-carbon unsaturation. Oxidation at such sites will convert such contaminants to species which are much less toxic. This report presents a kinetic study and mechanistic conclusions about the epoxidation of cyclohexene with t-butyl hydroperoxide as catalyzed by vanadyl acetylacetonate. Kinetic data indicate that the epoxidation proceeds through a hydroperoxide-vanadium complex and that this catalytically active species is a vanadium (V) derivative which is formed in a series of rapid steps before the epoxidation itself gets under way. The epoxidation is retarded by the product t-butyl alcohol, and the rate law for the retarded reaction indicates competitive inhibition of alcohol through 1:1 and 1:2 vanadium-alcohol complexes. The structural features required for metal catalysis are considered.
W68-00652

5C. Effects of Pollution

USING WASTE HEAT FOR FISH FARMING,
Maryland Univ, College Park.
P. A. Martino, and J. M. Marchello.
Ocean Ind, Vol 3, No 4, pp 36-39, Apr 1968. 4 p, 2 fig, 12 ref.

Descriptors: *Waste water disposal, *Heated water, *Fish farming, Aquicluture, Cycling nutrients, Desalination plants, Nuclear powerplants, Marine fisheries, Cost-benefit ratio, Economics, Design criteria, Ocean circulation, Water temperature, Heat flow.
Identifiers: *Waste heat, *Thermo-nutrient pumping, Sea food, Fish yield, Pumping conditions, Fish production.

Quantitative evaluation is made of the possibility of utilizing industrial waste heat, such as from a sea coast nuclear power plant, for convectively pumping up nutrient-rich deep water for fish farming. Thermo-nutrient pumping conditions are described and illustrated; design criteria are outlined for various operating schedules. Curves show different equations for pipe diameters and flow rates. Cost estimates are given. For example, a 1-meter diameter vertical pipe with delta T = 5 deg C can deliver 300 kg/sec of nutrient-rich water when 60 kg/sec of heat exchanger water is injected at the bottom; this can produce about 3,000 kg of edible fish. Pipe diameter would have to be multiplied in accordance with environmental conditions, amount of available heat, and cost-benefit ratio. A suggestion is made for a joint scheme between a coastal nuclear and desalination plant and offshore oil fields and a fish farming project. A plant producing 100 mgd of fresh water would return 10,000 kg/sec of heat exchange water to the ocean.
W68-00338

INDUCED EUTROPHICATION - A GROWING WATER RESOURCE PROBLEM,
FWPCA, US Dept. of the Interior, Cincinnati.
A. F. Bartsch.
Trans 1960 Sem on Algae and Metropolitan Wastes, Robt A Taft Sanitary Eng Center, Tech Rept W61-3, pp 6-9, 1961. 4 p.

Descriptors: *Eutrophication, Sewage, Fish populations, Plankton, *Cyanophyta, Washington, DC, *Estuaries, Human population, Sewage effluents, Aquatic populations, Nuisance algae, Ducks (Wild), Oysters, Channels, Pollution abatement, Human population.

A familiar thread of similarity and repetition can be noted in each case of eutrophication. Sometimes it includes all, but more commonly only several, of the following steps: (1) introduction of raw or treated, sewage; (2) replacement of prized deep-water trout or whitefish by less desirable kinds; (3) increase in plankton or free-floating plant and animal life; and (4) explosive seasonal appearance of the cyanophyte, Oscillatoria rubescens. The Potomac River below Washington, DC, is another of the susceptible bodies of water. Here it is a tidal reach, where the water washes back and forth, and is as much like a lake as a river. The immediate tributary land area is occupied by a concentrated

sewered population of 1.7 million people. Limited intermittent studies during the last few years reveal that algal populations are much greater now than in the past. Blooms of cyanophytes are common and may become objectionable in some of the bays and coves. Long Island ducklings also contribute to the enrichment. The area normally raises fine oysters but the oyster beds become polluted unless channels are dredged to allow the flushing of the bay by the tides.
W68-00461

LIMNOLOGICAL SURVEY OF LAKE ERIE 1959 AND 1960,
Wisconsin Univ., Milwaukee, Great Lakes Res. Ctr.
A. M. Beeton.
Great Lakes Fish Comm, Tech Rept No 6, 32 p, 1963.

Descriptors: *Eutrophication, Great Lakes, *Lake Erie, *Dissolved oxygen, History, Analyses, Effluents, Rivers, Chemical properties, Water pollution, Physical properties, *Hypolimnion, Limnology, Surveys, *Hydrologic data.

This report verifies certain earlier conclusions (1960 and 1961) of the author that a large area of Lake Erie, particularly within the central basin, has low oxygen values. Several agencies, federal, state, and university, employing various kinds of vessels made transects across Lake Erie, over the central basin in 1959, and throughout the entire area of the lake in 1960. About 70% of the bottom waters of the central basin had a serious deficiency in oxygen in 1959 and 1960. Other analyses were made to determine alkalinity, conductivity, temperature, transparency, pH, and phenolphthalein alkalinity. These latter were related to distributions within the lake of river effluents, such as those of the Maumee and Detroit Rivers.
W68-00462

SCIENTIFIC STUDIES AND CHEMICAL TREATMENT OF THE MADISON LAKES,
City of Madison, Madison, Wisc.
Bernhard Domogalla.
A Symposium on Hydrobiology, Univ of Wisconsin Press, Madison, pp 303-309, 1941. 7 p, 3 fig, 4 tab, 8 ref.

Descriptors: *Eutriphication, *Lakes, Wisconsin, Copper sulphate, Nuisance algae, *Algal control, Weed control, *Investigations, Zoo-plankton, Spraying, Biocontrol, Infection, Nutrients, Algae, Nitrogen, Phosphorus, Bicarbonates, *Aquatic populations.
Identifiers: Saprolegnia.

Studies of chemical treatments applied to the Madison lakes indicated: (1) Spraying with copper sulphate and other chemical treatments was found to be the most effective and economical method of controlling growths of obnoxious algae and weeds. (2) Studies showed that the chemical treatments as they were made did not seriously injure the zooplankton. (3) The chemical treatments for control of algae also controlled saprolegnia. (4) Chemical spraying also brought 'swimmer's itch' and fungus infections under control. (5) Studies over an 18-yr period indicate that nitrogen compounds, phosphorus, and bicarbonates are among the factors that tend to promote the excessive growth of algae and large aquatic plants. Chemical treatment with copper sulphate reduced the numbers of algae in the Madison lakes but did not eliminate them. These algae identified in Lake Monona in 1940 were, in descending order of abundance: Anabaena, Microcystis, Pediastrum, Lyngba, Staurastrum, Fragilaria, Hydrodictyon, and Pandorina.
W68-00468

FERTILIZATION AND ALGAE IN LAKE SEBASTICOOK, ME.
FWPCA, Dept. of the Interior, Cincinnati.
Rept of the Tech Advisory and Investigations Activities of the Tech Services Program, Fed Wtr Poll Contr Adm, Robt A Taft Engg Center, Cincinnati, Ohio, 122 p, 1966.

Descriptors: *Eutrophication, Maine, Nutrients, Aquatic populations, Water quality, Lake morphometry, Domestic wastes, Plant growth substances, Limnology, Plant growth regulators, Cyanophyta, Environmental effects, Currents (Water), Industrial waste, Cores, Diatoms, Odor-producing algae, Chlorophyll, Chemtrol, Copper sulfate, Lakes, Nitrogen.
Identifiers: Microcystis, Anabaena.

In 1965, a study was made of Lake Sebasticook, Me, by the Tech Advisory and Investigations Activity and the Me Wtr Impr Comm. The area of the lake is 1,736 ha, its max depth is 17.7 m, and its mean depth is 6 m. Sampling was done in Feb, May, Jul, and Oct in the effort to determine the major sources of nutrients, to assess their significance, and to recommend their control. Data indicate that about 98% of the nutrients come from sources other than land drainage, the bulk (75%) from domestic and industrial (including woolen mills and a potato-processing plant) wastes. Extensive blooms of the blue-green algae, Microcystis aeruginosa and Anabaena spp, produce objectionable mats and odors. The average detention time in the lake is 3.5 yr. Phosphorus is judged to be the most significant nutrient and is followed in importance by nitrogen. The phosphorus input exceeds its output. A limited analysis of a 48 cm core showed an increase in diatoms in the top few cm. Chlorophyll content fluctuates widely. Statements by residents and others indicate that most of the changes in the lake occurred within the past 10-20 yr. Chemical control by the use of copper sulfate is not recommended because it would be only temporary and too expensive, up to $40,000/yr.
W68-00470

THE NEED FOR NUTRIENT CONTROL,
Metcalf and Eddy, Boston.
C. N. Sawyer.
Water Poll Control Fed Jour, Vol 40, No 3, pp 363-370, Mar 1968. 8 p, 5 fig, 1 tab, 11 ref.

Descriptors: Control, Eutrophication, Nitrogen, Nutrient, Phosphorus, Reduction, Retardance.
Identifiers: Arresting, Removal, Process.

Nutrient control is needed to arrest eutrophication lakes and streams. Cultural drainage is a major contributor of nutrients and a logical point of attack on the problem. Soil erosion control and prevention of leaching from animal manures are helpful agricultural practices. Phosphorus removal offers the most promise for eutrophication control, since some blue-green algae can fix nitrogen and other nutrients are present in natural waters or exist in quantities too small for practical removal. Chemical analysis of the lake water frequently during the year can determine which nutrients are critical, i.e., which nutrients decline in concentration as primary productivity increases.
W68-00471

CHANGES OF EUTROPHICATION AND BIO-PRODUCTION MEASURED BY THE BIOMASS-TITRE OF TEST ALGAE (GERMAN),
Bundesgesundheitsamt, Institut fur Wasser-, Boden- und Lufthygiene, Bad Godesberg, W. Germany.
G. Bringmann, and R. Kuhn.
Gesundheits-Ingenieur, Heft 2.79, pp 50-54, 1958. 5 p, 10 fig, 1 tab.

Descriptors: *Eutrophication, Test analysis, *Laboratory tests, Test procedures, Nurtrients, Rivers, Lakes, *Growth rates, *Water temperature, Seasonal, Test procedures, Scenedesmus, *Algae.
Identifiers: Berlin (West), Germany.

The article describes a continuation of the work of Bringmann and Kuhn in which a bio-assay technique was used to estimate the influences of enrichment on the streams and other bodies of water in the Berlin (West) water net. By comparing water temperatures and the bioproduction of the test algae, the authors noted that the highest production occurred during the winter when water temperatures were low, and vice versa. As based upon meager data--about 9 samplings a year for temperature and 7 samplings a year to determine bio-production--temperature and production were usually found to be out of phase. Values were compared for the interval from May 1956 to April 1957. Scenedesmus was used again as the test organism.
W68-00472

THE ARTIFICIAL VENTILATION OF LAKE PFAEFFIKER (GERMAN),
EAWAG, Zurich, Switzerland.
H. Ambuhl.
Verbands-Bericht USA, Nr 77/3 pp 1-9, Dec 1962. 9 p, 6 fig.

Descriptors: *Eutrophication, *Freshwater lakes, Lakes, Aeration, Lake morphometry, On-site data collections, Water temperature, *Dissolved oxygen, Anaerobic conditions, *Ventilation, Water treatment, *Water quality control.
Identifiers: Lake Geneva, Switzerland.

Pfaeffikersee is a lake in Switzerland with these dimensions: length, 2.6 km; width, 1.4 km; surface area, 3.25 sq km; maximun depth, 35 m; mean depth, 18 m; volume, 65,450,000 cu m; mean discharge, 2.5 cu m/sec; area of drainage basin, 43.5 sq km. It was the site of an experiment to learn the effects of artificial ventilation. The ventilating device, a cylindrical tube about 2 m in diameter, was installed from just above the bottom of the lake to just below the surface of the water. Water was circulated in it by the force of compressed air. The experiment, from July 1958 Fall 1962, was discontinued during the winters. The tube placed in 3 test positions produced no great differences in results. Ventilation caused the temperature and oxygen content of Lake Pfaefferiker to increase over that of nearby Lake Greifen, but anaerobic conditions developed in both lakes during the summers. The nitrate content rose and the ammonia content fell in Pfaeffiker but these contents were reversed in Greifen. Hydrogen sulfide was present in small amounts or not at all in Pfaeffiker, presumably an improvement in water quality resulting from ventilation. Effective ventilation requires that sewage influx be stopped.
W68-00474

THE ALGAE-TITRE AS A MEASURE OF EUTROPHICATION OF WATER AND MUD (GERMAN),
Institut fur Wasser-Boden-und Lufthygiene, Berlin-Dahlem, Germany.
G. Bringmann, and R. Kuhn.
Gesundeits-Ingenieur, Vol 77, pp 374-381, 1956. 8 p.

Descriptors: *Eutrophication, Algae, Germany, Volumetric analysis, Limnology, Growth rates, *Laboratory tests, *Scenedesmus, Diatomaceous earth, Mud, Lakes, Cultivation, Channel morphology, Sewage input, Biological properties, *Water quality, Turbidity, Plant populations.
Identifiers: Berlin, *Algae-titre.

Algae of the genus Scenedesmus were injected into mud samples and into water samples filtered free of algae. These were then cultivated under constant conditions for uniform periods, after which the turbidity, a function of the number of organisms, was determined. The nephelometric value is generally equivalent to mg/l of infusorial soil. The equivalent value of infusorial soil served as a measure of turbidity and is termed 'algae-titre.' The relation of the algae-titre to the discharge channel and to the sewage input was demonstrated. Experiments showed that algae-titre may serve as a biological measure of the eutrophication of water and mud. Data were derived from samples taken at 41 places

in the Berlin water net during 14 days from July 1955 to Jan 1956. The average values of algae-titre were then compared on several bases. The authors have used the method in routine tests of water quality.
W68-00475

EUTROPHICATION PROBLEMS AND PROGRESS,
Pacific Northwest Water Laboratory, FWPCA, Corvallis, Oregon.
A. F. Bartsch.
Min 152nd Mtg, Mo Bas Inter-agency Comm, Bismarck, N Dak, Append G, pp G-1/G-7, Mar 1968.

Descriptors: *Eutrophication, Lakes, *Nutrients, United States, Phosphorus, Nitrogen, Sewage, Industrial wastes, Domestic wastes, Sewage treatment, Harvesting of algae, Bottom sediments, Weed control, Solar radiation, *Water pollution control, Algicides, Biocontrol, *Watershed management, *Environmental effects, Chemtrol, Algae.
Identifiers: Crater Lake, Ore, Growth rates, Water properties.

There are all deg of eutrophication in the 100,000 small lakes of the USA. Citizens and their agencies are increasingly aware of the threat. The dense algal growth of advanced eutrophication is the result of addition of certain nutrients to water: only .4 oz of phosphorus or 1 lb of nitrogen mixed with an acre ft of water will support an objectionable growth. Man contributes great quantities of nutrients in sewage, industrial wastes, and the fertilizers washed from farmlands. 4 nutrient-control measures are: (1) mechanical removal of plants from the water; (2) controlling plant growth by the addition of certain chemicals; (3) biological control by introducing plant-killing fungi and viri; and (4) ecological control by: (a) reducing the input of phosphorus and nitrogen (sewage diversion, perhaps); (b) treatment of sewage to remove most of the phosphorus before discharge to a lake; (c) dilution of the nutrients already present by flushing of lake (Moses Lake, Wash); and (d) removing nutrients by harvesting algae (not now feasible) and waterweeds (now possible). Estimates are that if waterweed harvest can be 3X the nutrient input, eutrophication can be controlled. Bottom-sediment/nutrient interchange, and the effect of reducing insolation are being studied.
W68-00478

ALGAE BLOOMS IN LAKE ZOAR, CONN,
General Dynamics Corp., Groton, Conn.; Water Resources Comm., Hartford, Conn.
R. J. Benoit, and J. J. Curry.
Trans 1960 Sem on Algae and Metro Wastes, Robt A Taft Sanitary Engg Center, Cincinnati, Ohio, Tech Rept W61-3, pp 18-22, 1961. 5 p.

Descriptors: *Eutrophication, *Pollution abatement, Drainage systems, Flow rates, Conn stream flow, Algae, Aquatic algae, Currents (Water), Limnology, Lakes, *Pilot plants, *Nuisance algae, Rooted aquatic plants, *Reservoirs, Hydroelectric plants, Weed control, Water properties, Phosphorus, Chemical analysis.
Identifiers: Hydrodictyon, Elodea, Ceratophyllum, Microcystis, Anabaena.

Lake Zoar, Conn, was impounded in 1919 behind the Stevenson Dam across the Housatonic River. The drainage area above that point is about 1,545 sq mi. During high-flow stage (2,500 cfs) the lake waters are replaced every 9 days; during low-flow periods (Aug and Sept) the replacement time is 40 days. By 1947 the increase in algal growth had been so great as to create a serious nuisance. Rooted aquatic plants were first designated as the nuisance-causing organisms but algal blooms were found to be equally important. Hydrodictyon occurs in mid-Jul in great quantities in the shallow, quiet waters and is intimately associated with such aquatic weeds as Elodea and Ceratophyllum. Currents move floating mats of weeds from one place to another. In the early summer, large quantities of Microcystis and Anabaena appear in the uppermost 4-ft zone of lake water. Phosphorus concentrations measured in the waters of the lake and source streams range from 12-41 ppb and average about 25 ppb. The pollution-control agencies constructed a pilot plant on the plan suggested by Lea, Rohlich, and Katz (1954). It was partly destroyed by a flood and, despite apparently successful operation, was not rebuilt because an investigation by an independent agency found an unexplained increase in phosphorus content.
W68-00479

THE EFFECT OF SEWAGE ON A CHAIN OF LAKES IN INDIANA,
Duke Univ. Marine Laboratory, Beaufort, NC.
John M. Dean.
Hydrobiologica, Vol 24, pp 435-440, Sept 1964. 6 p, 2 fig, 6 ref.

Descriptors: *Eutrophication, *Lakes, Lake morphometry, Indiana, Streams, *Water pollution, Sewerage, Aquatic populations, Phytoplankton, Sludge, Invertebrates, Statistics, Bibliographies, Cyanophytes, Pollutant identification.
Identifiers: Sewage plant designs.

Studies of a chain of small lakes in Northeastern Indiana indicate that the effects of pollution by sewage decrease with increase in distance from the point of sewage discharge. Treated and untreated sewage is discharged from the disposal plant serving Angola, Ind (population, 5000). The plant has a design capacity of 500,000 gpd but has been hydraulically overloaded since 1949, by 200,000 gpd in 1960. The sewage is discharged into Mud Ditch (2.5 mi long) then through Pigeon Creek, into Long Lake, Big Bower, Golden, and Hogback Lakes. Mud Ditch is grossly polluted, and both flora and fauna of Pigeon Creek and the downstream Lakes are pollution-depressed. Sludge build-up in Long Lake is pronounced but diminishes in the lower lakes. Cyanophytes, indicators of organic enrichment, are abundant in Long Lake and are fewest in Hogback Lake. Pollution-tolerant chironomids, tubifacids, and sphaerionids characterize Long Lake; small numbers of tubifacids and chironomids are present in the lower lakes. Pigeon Creek above Mud Ditch is a healthy stream, thus agricultural drainage does not contribute as much enrichment as does effluent from the sewage plant.
W68-00480

NUTRIENTS AND ALGAE IN LAKE SEBASTICOOK, MAINE,
FWPCA, Cincinnati, Ohio.
K. M. Mackenthun, L. E. Keup, and R. K. Stewart.

Jour Water Poll Control Fed, 40, 2 Part 2, R72-R81, Feb 1968. 10 p, 6 fig, 3 tab, 9 ref.

Descriptors: Algae, Eutrophication, Lakes, Microorganisms, Nitrogen, Nutrients, Phosphorus, Plankton, Plants (Organisms).
Identifiers: Lake Sebasticook, Me, Maine, Periodic variations, Seasonal variations, Sources.

Four seasonal field studies were made on Lake Sebasticook, Maine, and its surrounding area, to determine the cause of nuisance algal growths, identify major nutrients sources, assess their significance, and recommend control measures. In February total nitrogen values were 3.3 mg/l in the lake's surface waters and 6.2 mg/l in the profundal waters. Values were lower during other seasons. There was no reduction in nitrogen passing through the lake. The lake received 8,000 lb (3,630 kg) of total phosphorus annually, discharged 4,150 lb (1,880 kg), and retained 48 percent. Phytoplankton were as high as 2,260 lb/surface acre (2,540 kg/ha) (wet weight) during the maximum growing period. An 80 percent reduction in controllable inflowing phosphorus would correct the nuisance conditions.
W68-00481

THE EFFECTS OF POLLUTIONAL WASTES ON FISH LIFE,
Louisville Univ. School of Medicine, Louisville, Kentucky.
A. E. Cole.
A Symposium on Hydrobiology, U of Wisconsin Press, Madison, pp 241-259, 1941. 18 p.

Descriptors: *Eutrophication, Investigations, *Fish, Resistance, Chemical properties, Physical properties, *Pollutants, *Water-pollution sources, Absorption, Biological membranes, *Toxins, Phenols, Industrial plants, Ammonia, Decomposing organic matter, Sulfur compounds, Arsenic compounds, Chlorine.

Studies of the effects of water pollutants indicate that fish differ in their ability to withstand varying amounts of oxygen, carbon dioxide, rapid temperature changes, and dissolved salts. Two kinds of pollutants act directly on fish: 1. those that act directly on the epithelium of the gills and oral cavity, and 2. those true toxins that enter the body through the epithelium and affect the internal tissues. Phenol, a powerful irritant, coagulates mucous, hemolizes blood, and paralyzes muscles; phenolic wastes are produced by gas plants, refineries, oil wells, and wood-distillation plants. Ammonia produced by the decomposition of organic wastes may be toxic to fish. Toxic sulfur compounds are discharged from pulp mills and gas plants; hydrogen sulfide causes respiratory paralysis (0.86 mg/l of it will kill brook trout). Less than 1 mg/l of potassium cyanide, found in wastes from mines, coke ovens, and chemical works, is extremely toxic. Other toxins are arsenic compounds, chlorine, and chloramines that are found in bleaching powders and are used in water-purification plants. Food-processing plants have high BOD demands and so contribute to the lack of oxygen in water.
W68-00484

FERTILIZATION OF LAKES--GOOD OR BAD,
Mich Dept of Conserv.
Robert C. Ball.
Mich Conserv, Vol 17, No 9, pp 7-14, Sept 1948. 8p, 1 fig.

Descriptors: *Eutrophication, *Lakes, Nutrients, Oxygen requirements, Iced lakes, *Fertilization, Water fleas, Larvae, Growth rates, *Fresh water fish, Michigan, Trout, Winterkilling, Fishkill, Nuisance algae, Algae, Seasonal, Limnology, Light penetration, Oxygen, Sport fishing, On-site investigations.
Identifiers: Artificial fertilization, Commercial fertilizers.

Studies of 4 lakes in the northern part of the Southern Peninsula of Michigan indicate that inorganic fertilizers applied to the waters may benefit the fish populations in some lakes, but exert a harmful effect in others. 2 pairs of lakes were studied, 1 of each pair received the inorganic fertilizer and the other did not. The experiments had been carried on for 3 years by 1948. The addition of commercial fertilizer to small ponds increases the number of organisms upon which young fish feed. The nutrients in the fertilizer provide food for algae, the food for water fleas and insect larvae; these organisms in turn, are a food source for both yound and adult game fish. The addition of fertilizer seems to increase the total number of small game fish but does not result in growth to sizes of interest to game fishermen. Artificial fertilizer increases the growth of algae. It also favors the growth of less desirable species of game fish at the expense of trout. The heavy algal growth of over-fertilized lakes, tends to develop a serious oxygen deficiency when iced over in winter; exclusion of air and much of the sunlight causes the algae to die and, in their decay, to use up the oxygen needed by fish; severe winterkill of game fish results. Until more is known, the use of fertilizers in small lakes should be avoided.
W68-00487

ELEVEN YEARS OF CHEMICAL TREATMENT OF THE MADISONLAKES--ITS EFFECT ON FISH AND FISH FOODS,
City of Madison and Wis State Lab of Hygiene.
Bernhard Domogalla.
Trans Amer Fish Soc, Vol 65, pp 115-121, 1935. 7 p, 1 fig, 3 tab.

Descriptors: *Eutrophication, *Lakes, Wisconsin, Algae, *Nuisance algae, Spraying, Seasonal, *Algal control, Fishkill, Rooted aquatic plants, Glacial lakes, Plankton, Epidemics.
Identifiers: Secchi disc, Visibility tests, Control methods.

Lake Monona is the second of four glacial lakes in the valley of the Yahara River near Madison, Wis. Complaints of obnoxious odors and algal growths led in 1925 to studies of possible remedial measures. It was found that phosphorus, nitrogen, and bicarbonates were the nutrients that caused algal overgrowths. To control these growths, copper sulphate was first applied by dragging a bag filled with it through the water. Much more effective was the systematic spraying of the lake with the same chemical. The spraying reduced the growth of Cladophora and Ulothrix in May; Anabaena in Jun; Microcystis, Hydrodictyon, and Aphanizomenon in Jul and Aug; and Aphanizomenon, Cladophora, and Ulothrix in Sept. Rooted weeds were cut from under 600 ac of the 5.4 sq mi of the lake. Weeds in the deeper waters were not affected by the chemical spraying. Visibility tests showed depths of 4.3 m in Lake Monona as compared with 0.6 and 2.4 m in other lakes in the group. An epizootic among fishes infected with saprolegnia was particularly severe in 1930; however, the spraying of Lake Monona greatly reduced the fishkill there.
W68-00488

EFFECTS OF LIMNOLOGICAL FACTORS ON UPTAKE OF CESIUM-137 BY FISH,
Michigan State University.
Niles R. Kevern.
Annual Progress Report on Project to the Office of Water Resources Research, Dept. of the Interior, 1968.

Descriptors: *Cesium, *Fallout, Radioactivity, Water chemistry, *Limnology, *Radioecology, Lake fisheries.
Identifiers: Cesium radioisotopes, Specific activity.

The influence of certain limnological factors on the uptake of cesium-137 fallout is being investigated in a series of lake types. Multiple regression analysis will be used to determine which of the factors are the most important. The factors measured in each of the six lakes will be cesium-137, stable cesium, sodium, potassium, and specific conductivity along with the standard limnological measurements of pH, alkalinity, temperature, dissolved oxygen, and secchi disc readings. Measurement of the concentrations of cesium-137 and stable cesium in samples of largemouth black bass from each lake and in the lake waters will allow demonstration of the importance of the specific activity of the water on the accumulation of cesium-137 by fish. Results to date show the concentration of cesium-137 in bass to be 1.27 plus or minus 0.13 S.E. picocuries per gram live weight. This concentration is easily measureable, but certainly not hazardous. The concentration of naturally occurring potassium-40 in bass is 4.47 plus or minus 0.14 S.E. picocuries per gram live weight.
W68-00489

EUTROPHICATION OF SURFACE WATERS-LAKE TAHOE,
Lake Tahoe Area Council, South Lake Tahoe, California; FWPCA, Washington, DC.
P. H. McGauhey, G. A. Rohlich, and E. A. Pearson.

Lake Tahoe Area Council, First Progress Report, FWPCA Grant No. WPD-48, May 1968. 175 p, 31 references.

Descriptors: *Eutrophication, *Bioassay, *Essential nutrients, Analytical techniques, Water analysis, Water quality, *Continuous bioassay, *Batch bioassay.
Identifiers: *Eutrophication, Bioassay, *Chemostats, Batch cultures.

Increasing eutrophication of surface waters in the U.S. has directed attention to a need for methods of assaying influents. The need for applying bioassay techniques to determine the algal growth stimulating potential of influents to surface waters is particularly acute at Lake Tahoe because of the uinque clarity of the Lake waters. Both batch and continuous chemostat techniques were applied in the laboratory to determine the biostimulatory effects on Lake Tahoe water of various concentrations of sewage effluents, surface runoff, and seepage from inhabited and uninhabited land areas as a prelude to demonstration tests with pilot ponds simulating shallow areas of the Lake. The green alga S. gracile was used as a test organism, with the specific or maximum mass growth rate of cells as the principal parameter of growth response. Lake Tahoe as well as the majority of inflows to the Lake were found to be nitrogen-limiting. Added phosphorus had little effect on eutrophication. Algal growth rates for sewage effluents were found to be significantly higher than that resulting from equivalent concentrations of nitrogen and phosphorus. Numerous shortcomings of bioassay techniques are identified.
W68-00501

DENITRIFICATION AS A NITROGEN SINK IN LAKE MENDOTA, WIS,
Water Chem Lab, U of Wis, Madison, Wis.
P. L. Brezonik, and G. F. Lee.
Environmental Sci and Tech, Vol 2, No 2, pp 120-125, Feb, 1968.

Descriptors: *Eutrophication, *Lakes, Wisconsin, *Nitrogen, *Hypolimnion, Radioactivity techniques, Oxygen sag, Statistics, *Denitrification, Nutrification, Deposition (Sediments), Profiles, Nitrogen sinks, Sediments, Water chemistry, Analytical techniques.
Identifiers: *Denitrification, Nitrates, Nitrites, *Nitrogen cycle.

The significance of denitrification as a sink in the nitrogen budget has been determined for Lake Mendota, Wis. About 28,100 kg of nitrogen were lost from the lake hypolimnion during the summer of 1966. However, this relatively large amount represented only about 11% of the estimated total annual nitrogen input. Denitrification rates ranged from 8 to 26 ug of N per l per day, while rates of nitrate reduction (to ammonia and organic nitrogen) were found by N-15 tracer techniques to range from 1.4 to 13.4 ug of N per l per day in the hypolimnion of the lake. Nitrate depletion is more than an order of magnitude slower than oxygen depletion in the hypolimnion of Lake Mendota, and denitrification is probably not significant with respect to respiration and catabolic processes in the lake hypolimnion. There is some evidence to indicate that dissolved nitrogen gas concentrations increase above those expected on the basis of solubility as the result of denitrification. Evaluation of various nitrogen sinks for Lake Mendota has revealed that only about one thrid of the estimated annual nitrogen input can be accounted for by currently evaluated sinks. Sediment deposition probably account for most of the remaining two thirds.
W68-00510

NUTRIENT BUDGET: RATIONAL ANALYSIS OF EUTROPHICATION IN A CONNECTICUT LAKE,
Dept of Soils Climatol, The Conn Agr Exp Station, New Haven, Conn.
C. R. Frink.
Environmental Sci and Tech, Vol 1, No 5, pp 425-428, May 1967. 4 p.

Descriptors: *Eutrophication, *Lakes, Connecticut, Water pollution, *Nutrient requirements, *Bottom sediments, On-site data collections, Aquatic plants, Watershed, Algae, Aquatic vegetation, Nitrogen, Phosphorous, Available nutrients, Sediment cores.
Identifiers: *Sediments, *Nutrient budget, Cycling nutrients.

The significance of nutrient contamination of water by man can be evaluated only by comparison with all other sources. In an exemplary eutrophic lake in northwestern Connecticut, the nutrient input from a largely forested watershed with no overt source of pollution was adequate to support the observed abundant vegetative growth. In addition, a vast accumulation of nutrients was found in the lake bottom sediments; the upper centimeter of sediment contains at least 10 times the estimated annual input of nitrogen and phosphorus. Moreover, this reservoir of nutrients in the sediments should be capable of supporting plant growth for some time even if all nutrients could be excluded from the lake. Apparently, the abundant weeds and algae in this lake are the result of natural eutrophication which man will be hard pressed to alter.
W68-00511

FURTHER OBSERVATIONS INCONSISTENT WITH THE HYPOTHESIS THAT THE MOLYBDENUM BLUE METHOD MEASURES ORTHOPHOSPHATE IN LAKE WATER,
Toronto University, Department of Zoology, Toronto, Ontario.
F. H. Rigler.
Limnol and Oceanogr, Vol 13, No 1, pp 7-13, Jan 1968. 7 p, 1 fig, 4 tab, 10 ref.

Descriptors: *Molybdenum, Inorganic compounds, *Phosphates, *Lakes, Ponds, Water chemistry, Analytical techniques, Tracers, Surface water, Standards, Hydrolysis, Anion exchange.
Identifiers: *Orthophosphate, Molybdenum blue test, Radiobiological analysis, Ontario, Canada.

Use of a radiobiological method for analysis of lake waters for soluble orthophosphate is described. The results of 3 different observations of lakes in Ontario, Canada, can be explained by postulating that the concentration of inorganic phosphate in lake water is much lower than indicated by the molybdenum blue test. Hydrolysis of organic phosphorus compounds is hypothesized as a source of error. This hypothesis is being tested further.
W68-00515

MACROINVERTEBRATE COMMUNITIES OF THE SEDIMENTS OF HAMILTON BAY AND ADJACENT LAKE ONTARIO,
Ontario Water Resources Commission, Toronto, and Municipal Laboratories, Hamilton, Ontario.
M. G. Johnson, and D. H. Matheson.
Limnol and Oceanogr, Vol 13, No 1, pp 99-111, Jan 1968. 13 p, 5 fig, 4 tab, 8 ref.

Descriptors: *Productivity, *Industrial wastes, Bays, Canals, *Lake Ontario, *Hydrodynamics, Water chemistry, Sewage bacteria, Sewage effluents, Sediments, Municipal wastes, Biological communities, Dominant organisms, Environmental gradient, Aquatic habitats.
Identifiers: *Macroinvertibrates, Steel plants, Sublittoral sediments, Filter-feeding animals, Plume.

The distribution and abundance of benthic macroinvertebrates in Hamilton Bay and Lake Ontario are described and related to physical and chemical characteristics of the water and sediments and to hydrodynamic factors. Profundal sediments in Hamilton Bay are rich in organic matter and contain an abundance of Limnodrilus hoffmeisteri and Tubifex tubifex; lesser numbers of 5 Limnodrilus species occupied poorer sublittoral sediments. No macroinvertibrate community was observed in sediments having more than 25% Fe203. More favorable water chemistry, circulation, and

moderately rich sediments near the canal connecting the bay with Lake Ontario increases biomass of oligochaetes over that in the richer, profundal sediments in the main basin of the bay. In Lake Ontario the oligochaetes species increased in numbers with increasing depth and sediment richness. Discharge of bay water to the lake influences the specific composition of macroinvertibrate communities.
W68-00566

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS. PHASE I,
Rhode Island Univ., Kingston, Rhode Island.
Harry Perry Jeffries.
Grad School Oceanogr, Univ of R I, Ref 67-4, Tech Rept 1, WP-00858 (mimeo), 76 p, 14 tab, 13 fig, 31 ref.

Descriptors: *Amino acids, *Lipids, *Estuarine environment, Salinity, Bioindicators, Water pollution effects, *Water temperature, *Biomass, *Comparative productivity, Ecological distribution, Environmental gradient, *Primary productivity, *Secondary productivity, *Copepods, Incineration, Fish types.
Identifiers: *Fatty acids, Homeostasis, *Seasonal succession.

The goal is to identify and measure quantitatively the internal responses of marine organisms to environmental stress. The responses are measured in terms of homeostatic adjustments of free amino acids, fatty acids, major lipid classes and blood proteins. Free amino acids in estuarine plankton are an index of the community's physiological condition and productive capacity: the levels decrease, in response to thermal stress, preceding seasonal succession of species populations. Quantitative interrelationships of the variables reflect community stability and its propensity for change. Furthermore, a discrete chain of copepod populations extending from oceanic to fresh waters shows evolutionary adaptation of the species' free amino acid pools. The concentrations of palmitic and palmitoleic acids are anothermeasure of community condition. When the ratio decreases, the zooplankton is plentiful; an increasing ratio signifies environmental stress, reduced production and impending community changes. Since the important relationships in the seasonal behavior of major metabolites are understood at the community level, attention is focused on the responses of individual species to controlled conditions in the laboratory and in modified natural environments.
W68-00578

LOVE PETROLEUM CO V JONES (LEGAL DAMAGES ARISING FROM EFFECT OF POLLUTANTS IN A STREAM).

205 So 2d 274-276 (Miss 1967).

Descriptors: *Water pollution, Water pollution sources, Oil waste, Saline water, *Mississippi, Judicial decisions.

Oil and salt water escaped from the defendant's well and ran into a creek which passed through plaintiff's land, killing trees along the border of the creek, killing fish in the creek, and causing plaintiff's cows to refuse to drink from the creek. The Mississippi Supreme Court held that the plaintiff landowner was entitled to at least nominal damages as a result of the nuisance created by the defendant. The plaintiff was also granted all special damages which accrued as a direct result of the nuisance.
W68-00631

5D. Waste Treatment Processes

SYSTEMS ANALYSIS FOR PLANNING WASTEWATER TREATMENT PLANTS,
Cornell University, Ithaca, NY and Northwestern University, Evanston, Ill.
Walter R. Lynn, John A. Logan, and A. Charnes.
Water Pollution Control Federation Journal, Vol 34, No 6, pp 565-581, June 1962. 17 p, 17 fig, 4 tab, 10 ref, 1 append.

Descriptors: Linear programming, Waste water treatment, Operations research, Unit costs, Total costs, Biochemical oxygen demand, *Network design.
Identifiers; *Dyadic models, Unit processes.

A sequence of sewage treatment unit processes were examined to determine the minimum cost combination of processes necessary to satisfy the effluent requirements. A constant input level of biochemical oxygen demand was assumed. The efficiencies of the unit processes were considered as constant. An example problem was solved, using existing data, to elucidate the mathematics of network analysis. The network formulation was transformed into a dyadic model. An efficient procedure for calculating the least cost solution was presented. This was one of the first papers which introduced systems analysis as a technique for determining an economical combination of unit processes necessary to remove a specific quantity of biochemical oxygen demand.
W68-00384

COMPUTER AIDED DESIGN OF WASTE COLLECTION AND TREATMENT SYSTEMS,
Michigan Univ., Ann Arbor.
Rolf A. Deininger.
Proc. Second Annual American Water Resources Conference, Chicago, Ill. pp 247-258, Nov 1966. 12 p, 5 fig.

Descriptors: *Computer programs, Waste water treatment, Digital computer, Linear programming, *Capital cost, Network design, Economies of scale.
Identifiers: *Time-sharing.

A summary of three research topics concerned with the feasibility and limitations of the design of waste collection and treatment systems by digital computers was presented. The results of the three research topics were: (1) the minimum cost of excavation and pipe for a sewer system was solved by linear programming techniques; (2) a regional approach to the design of waste collection and treatment systems with the objective of minimizing the collection and treatment costs was presented. An iterative procedure using linear approximations of the objective function was used to solve the problem; and (3) automatic plotting equipment was examined for the generation of construction plans for a treatment plant. The concepts of a time-sharing computer system were used for the plotting.
W68-00395

LINEAR PROGRAMMING APPLIED TO WATER QUALITY MANAGEMENT,
Cornell University, Ithaca, NY.
Charles S. ReVelle, Daniel P. Loucks, and Walter R. Lynn.
Water Resources Research, Vol 40, No 1, pp 1-9, Feb 1968. 9 p, 2 fig, 4 tab, 9 ref.

Descriptors: Linear programming, Dissolved oxygen, Biochemical oxygen demand, Oxygen sag, *Water pollution control, Optimum development plans, Total cost.
Identifiers: *Water quality constraints, Willamette River.

A linear programming formulation to minimize the cost of waste treatment in the Willamette River Basin subject to maintaining a minimum concentration of dissolved oxygen was presented. Actual data from the Willamette River Basin was used. A comparison was made to a dynamic programming solution. Both techniques yielded essentially the same results. Opportunities for cost reduction were examined by studying the dual variables. It was concluded that such information could be extremely important to those responsible for water quality management.
W68-00397

THE APPLICATION OF OPTIMIZATION TECHNIQUES TO TEXTILE MILL WASTE TREATMENT,
O'Brien and Gere, Charlotte, NC and North Carolina State University, Raleigh.
H. M. DeBruhl, and Charles Smallwood.
Fifteenth Southern Water Resources and Pollution Control Conference, North Carolina State at Raleigh, April 7 1966. 24 p, 7 fig, 5 tab, 3 ref.

Descriptors: *Linear programming, Biochemical oxygen demand, Dissolved oxygen, Gross profits, Total cost, *Textiles, Waste water treatment.
Identifiers: Present value, Simplex tableau.

Linear programming was used in maximizing profits for a textile mill operation by determining the optimal production level. The constraints of the problem were formed from the maximum and minimum production levels, the maximum discharge of biochemical oxygen demand, and the system configuration. Data was obtained from the literature. An example problem was solved illustrating the use of the simplex tableau. The results demonstrated: (1) the use of a model to determine production levels; and (2) the value of in-plant housekeeping.
W68-00400

CAPACITY EXPANSION OF WATER TREATMENT FACILITIES,
Harvard University, Cambridge, Mass.
Anton J. Muhich.
Thesis, Harvard University, Cambridge, Mass, April 1966. 184 p, 46 fig, 8 tab, 72 ref, 6 append.

Descriptors: *Water treatment, Water demand, Construction costs, Economies of scale, *Interest rate, *Growth rates, Operations research, Adjusted costs, Financial analysis, Budgeting, Water supply, Water costs, Elasticity of demand.
Identifiers: *Nonlinear programming, Uncertainty, Present value.

Mathematical models for the minimum construction cost of water treatment plants were presented to determine the levels and timing of a construction. The optimal solutions were related to the interest rate, the rate of growth in demand, and economies of scale inherent in treatment plant construction. Linear and geometric growth rates were used. Calculus techniques were used for the equal time interval construction models. A combination of sampling techniques and a gradient non-linear programming technique was used for the unequal construction time intervals. Allowing unequal construction intervals made little difference in the results. Existing construction cost data were used. Introduction of uncertainty had little effect on the decision process. It was concluded that existing rules of thumb used for design intervals caused a cost increase of three to five percent above the optimal design.
W68-00401

TERTIARY TREATMENT USING DIATOMACEOUS EARTH AND ACTIVATED CARBON,
Wayne State University.
Henry A. Dirasian.
Annual Progress Report of Project to the Office of Water Resources Research, Dept. of the Interior, 1968.

Descriptors: Water pollution control, Diatomaceous earth, Activated carbon, Fly ash, Filtration.

A study was conducted to determine the feasibility of treating secondary treatment plant effluents in a filter aid pressure type filter using diatomaceous earth as the filtering media while varying concentrations of activated carbon were added to enhance removals through adsorption; it was carried out in three phases. First, diatomaceous earth alone was used as filtering media. Next, activated carbon was added to diatomaceous earth, and finally, investigations were made using surplus fly ash as filtering

media. Secondary waste treatment plant effluents can be further treated by this method and additional organic matter removed. Using diatomaceous earth alone about 65% of the BOD was removed and about 93% in suspended solids. Using diatomaceous earth and activated carbon removals as high as 88% of BOD and 98% of suspended solids were attained. This type of treatment indicated improvement in the quality of effluents discharged to the stream. Emphasis should be placed on removals using fly ash as the filtering media. It was felt that fly ash could do an acceptable job. Some consideration would have to be given to grading and washing of fly ash before use. It is recommended that further studies be conducted on fly ash filters.
W68-00498

ADVANCED WASTE TREATMENT,
Federal Water Pollution Control Administration, Washington, DC.
L. W. Weinberger.
Water Resources Bull, Vol 4, No 1, pp 46-50, Mar 1968. 5 p.

Descriptors: *Water pollution control, *Waste water treatment, *Water utilization, Biological treatment, Biochemical oxygen demand, Organic matter, Nitrogen, Oxygen, Phosphorus, Distillation, Recreation, Water sports, Municipal water, Irrigation, Sludge disposal, Sewage effluents, Fertilizers.
Identifiers: *Water renovation, *Waste concentration, Physical-chemical separation, Gas hydration, Biodentrification, Wastewater purification.

A description is given of technologies in pollution treatment and the part played by the Advanced Waste Treatment program of FWPCA in the research of developing new and improved methodology. Treatment systems are being developed to alleviate pollution and to meet water quality demands imposed by reuse of wastewater for municipal, industrial, agricultural, and recreational purposes. Processes dealing with improvements and extensions of existing biological techniques not now employed are being researched. Degree of treatment depends upon intended use of the wastewater. Cost comparisons are given for several techniques currently used. Experimental systems are being tried in several places. It is concluded that by using the AWT processes now available (1968), it is possible to achieve any degree of waste treatment desired. In fact, it is possible to treat wastewater and return it to a quality at least as high as that of the water before use.
W68-00553

5E. Ultimate Disposal of Wastes

DEEP WELL INJECTION IS EFFECTIVE FOR WASTE DISPOSAL.

Environ Sci and Technol, Vol 2, No 6, pp 406-410, June 1968. 5 p, 5 fig, 1 photo.

Descriptors: *Injection wells, *Waste disposal, Brine disposal, Radioactive waste disposal, Riparian rights, Waste storage, Water quality act, *Chemical wastes, Liquid wastes, Thermal pollution, Earthquakes, *Legal aspects, Legislation, Permeability, Ohio, Water pollution control.
Identifiers: Toxic waste disposal, Waste disposal legislation, FWPCA, Geological consideration, Denver, Legal questions, Site selection.

A survey made of past and present waste disposal by injection indicates that deep wells are effective and that industry should make use of this method. Of about 40,000 brine disposal wells in use, 20,000 are in Texas. In the past 4 yr wells drilled for disposal of other industrial wastes have doubled in number to 110. Surface disposal methods are becoming restricted, and deep injection is perhaps the cheapest alternative. For very toxic wastes it is often the only feasible technique. A survey by FWPCA shows 32 wells in Texas, 24 in Louisiana, 21 in Michigan, 9 in Indiana, and 5 or fewer in each of 12 other states. Only Texas and Ohio have legislation referring specifically to industrial waste injection. Porous confined rock strata are required for injection; about 1/2 the U. S. is underlain by suitable rocks, predominantly in the central plains and southeastern coastal areas. Wastes must be low in solids and precipitable dissolved solids content. Heat generation can present problems in radioactive or chemical reactive wastes. Some controversy exists in Denver, where injection may be related to earthquake activity. The history and economics of Vistron's well in Lima, Ohio are given. Legal restrictions on well construction and operation must be studied before any construction is started.
W68-00326

FEASIBILITY OF SUBSURFACE DISPOSAL OF INDUSTRIAL WASTES OF ILLINOIS,
Illinois State Geological Survey, Urbana.
Robert E. Bergstrom.
Ill Geol Surv Circ 426, 18 p, 1968. 4 fig, 1 tab, 18 ref.

Descriptors: *Waste water disposal, *Injection wells, Illinois, *Industrial wastes, Permeability, Aquifers, Aquicludes, *Aquifer characteristics, Porosity, Legal aspects, Regulation, Environmental effects, Stratigraphy, Geologic control.
Identifiers: *Waste disposal wells, Aquifer compressibility, Acid waste disposal, Waste disposal regulation, Feasibility factors.

The factors bearing on feasibility and legality of industrial waste disposal wells are described, with main emphasis on geologic conditions and natural resources. The geologic conditions range from favorable for deep-well disposal in the Illinois basin, where the section is thick, many aquifers are confined, and deep groundwaters are highly mineralized, to unfavorable or questionable in the north where the section is thin and mainly permeable. Groundwater is fresh to great depth in the north and the deep aquifers are heavily pumped. The most promising disposal reservoirs in the south are the Ordovician St. Peter Sandstone and the Cambrian Ironton-Galesville and Mt. Simon Sandstones. These are important aquifers in the north. Other possible disposal zones include Pennsylvania and Mississippi sandstones, Devonian and Silurian limestones, and Ordovician and Cambrian dolomites. Of the 3 disposal wells in the State, one is in the Mt. Simon sandstone, one in a Devonian limestone, and one in a Cambrian dolomite.
W68-00530

5F. Water Treatment and Quality Alteration

WATER IS EVERYBODY'S BUSINESS--THE CHEMISTRY OF WATER PURIFICATION,
A. S. Behrman.
Doubleday and Co, New York, 229 p, 1968. 10 ref, 1 append.

Descriptors: *Water purification, Chemical engineering, *Water quality, Surface waters, Groundwater, Turbidity, *Water softening, *Desalination, Electrodialysis, Pollutants.
Identifiers: Textbook, *General discussion, Chemical quality, Water treatment, *Water-supply sources.

Of interest to laymen, students, and hydrology professionals in general, this text describes in broad terms the continuing role of the chemist and chemical engineer in water supply and purification. Chapter 1 discusses briefly the need for qualitatively pure water in sufficient supply for domestic, industrial, and agricultural purposes. The surface water--ground water dichotomy is specified in an outline of the hydrologic cycle. 6 chapters are devoted to water purity in general, and aspects of identification, measuring, turbidity, color, water softening techniques (cation- and anion-exchange resins), chlorination, dechlorinating agents, disinfection (by bromide, iodine, ozone, silver), removal of coliform bacteria, and defluoridation. Chapter 10 outlines different desalting processes (distillation, freezing, solar stills, hydrate formation, reverse osmosis). Electrodialysis of highly mineralized waters containing 2000-3000 ppm dissolved solids is outlined. Chapter 11 deals with the future of water in predicting more efficient metering of community water, reuse of industrially recovered waters, and application of protective films on surface waters to reduce evaporation loss.
W68-00336

DEVELOPMENT OF OPTIMIZATION MODELS FOR CARBON BED DESIGN,
Federal Water Pollution Control Administration, Cincinnati, Ohio, and Harvard University, Cambridge, Mass.
K. A. Dostal, R. M. Harrington, and R. M. Clark.
Journal American Water Works Association, Vol 58, No 9, pp 1170-1186, September 1966. 17 p, 10 fig, 6 tab, 13 ref.

Descriptors: *Linear programming, Operations research, Digital computer, Odor, Activated carbon, Unit costs, Capital costs, Operating costs.
Identifiers: *Present value, Materials balance, Deterministic model.

Economic and technological factors were incorporated into two linear programming models to determine the least cost preliminary design for the granular-activated carbon unit process. Only continuous reactivation was considered. The objective was to minimize the present values of the total cost. Actual data was used and example problems were solved. Each model was solved to determine the filter size, furnace capacity, and the rate of reactivation. The second model also specified the level of off-line storage. It was concluded that: (1) losses of carbon strongly affect present value; (2) changes in the economic time horizon and the unit cost of reactivating carbon has an influence on present value; (3) the models can be used for preliminary design; and (4) during seasonal demand patterns, it may be more economical to operate the furnace on an intermittent basis.
W68-00390

PROGRESS TOWARDS OPTIMUM DESIGN OF DIATOMITE FILTER PLANTS,
Iowa State University, Ames.
E. R. Baumann, John L. Cleasby, and Perialwar Regunathan.
5th Annual Sanitary and Water Resources Engineering Conference, Vanderbilt University, pp 124-154, June 2-3 1966. 12 fig, 7 tab, 11 ref.

Descriptors: Diatomaceous earth, Capital costs, Operating costs, *Computer programs, Digital computer, Simulation.
Identifiers: *Diatomite filter.

An objective of the study was to develop a rational minimum cost design technique for diatomite filters. A computer program was developed for use in determining the minimum total cost by enumerating different combinations of design variables. The design variables were flow rate, body feed concentration, and terminal head loss. The effect of plant size was also evaluated. The conclusions were: (1) the computer program can be used in optimization studies; (2) the use of one design filtration rate for all types of water should be avoided; (3) plant size has a significant effect on total cost; and (4) filtrability of water is very important.
W68-00399

5G. Water Quality Control

WATER AND ENVIRONMENTAL QUALITY.
Oregon State University, Corvallis, Oreg.

Oregon State Univ Water Resources Res Inst Fall Quarter 1967 Seminar, Corvallis, 116 p, Jan 1968. 6 fig, 6 tab, 57 ref.

Descriptors: Water resources, Surface waters, *Water management (Applied), Water policy, *Water pollution, Water quality, Water resources development, Water Resources Planning Act, *Water pollution treatment, Biochemical oxygen demand, Fisheries, Nutrients, Lakes, Eutrophication, *Oregon, Temperature.
Identifiers: *Water quality control planning, Willamette River basin, Environmental quality, Agricultural chemicals.

In the fall of 1967, a seminar group discussed the multiple water resources problems of Oregon. The speakers discussed not only the present situation regarding water quality in their fields of interest--forestry, industry, agriculture, urban development, recreation, and floods--but also possible solutions. Subjects covered by the published talks are the following: quality legislation and standards, status of Oregon's lakes, influence of forest management practices, influence of introduced agricultural chemicals, flood-plain planning, flood-plain management, stream temperature problems, quality problems and fisheries, Willamette River 'Greenway' plan, pulp mill wastes, municipal sewage pollution, and pollution of streams by agriculture. Each paper is a general discussion of the previous published work in its field and contains general recommendations for solutions of the problems. The paper on municipal sewage pollution presents, with graphic forms, current and projected waste data for the Willamette River basin.
W68-00342

QUALITY LEGISLATION AND STANDARDS,
Oregon State Sanitary Authority, Portland, Oreg.
Kenneth H. Spies.
Oregon State Univ Water Resources Res Inst Fall Quarter 1967 Seminar, Covallis, pp 1-11, Jan 1968. 11 p.

Descriptors: *Legislation, Permits, Planning, Water quality act, *Water law, Municipal wastes, Recreation wastes, Sewage disposal, Treatment, *Water pollution, *Standards, Treatment facilities, Oregon, Industrial wastes, Monitoring.
Identifiers: *Water quality legislation, Water quality standards, State aid, Tax benefits, Public hearings, *Water disposal.

The 7 laws passed by the 1967 Oregon Legislature to control water quality and set standards are listed and briefly discussed. Chapter 424, Oregon Laws 1967, changed Sanitary Authority membership. Chapter 426 strengthened public policy and the powers of the Sanitary Authority. Chapter 427 pertains to municipal bond issues to finance sewage works projects. Chapter 423 provides for state grants for financing community treatment plants. Chapter 592 provides tax benefits to industry for construction of air and water pollution control facilities. Chapter 567 controls mining of sand and gravel from stream beds. Chapter 624 provides for mandatory annexation of territory to a municipality to solve sewage disposal problems. For the first time in Oregon, pollution is adequately defined legally, in Chapter 426, which also initiates a system of mandatory disposal permits. The standards adopted for water purity were approved with commendation by the Secretary of the Interior.
W68-00349

ANALYSIS OF SEWAGE TREATMENT SYSTEMS BY SIMULATION,
Union Tank Car Company, Chicago, Ill; Cornell University, Ithaca, NY.
M. Mead Montgomery, and Walter R. Lynn.
American Society of Civil Engineers, Sanitary Engineering Division Journal, Vol 90, No SA1, Paper 3807, pp 73-97, Feb 1964. 25 p, 6 fig, 7 tab, 8 ref, 1 append.

Descriptors: *Low-flow augmentation, Digital computer, *Simulation analysis, Computer models, Dissolved oxygen, Waste water treatment, Synthetic hydrology, Organic loading, Waste assimilation capacity.
Identifiers: *Effluent storage.

The possibility of using low-flow augmentation and effluent storage in a sewage treatment system was evaluated by simulation on a digital computer. The model was time dependent. The inputs to the model were: (1) stream flow; (2) sewage flow; (3) biological oxygen demand concentration; (4) initial stream dissolved oxygen concentration; and (5) the coefficients of self-purification. Synthetic hydrology was used. Insight into the operation of a waste treatment system with various combinations of effluent storage, low-flow augmentation, and plant efficiencies was obtained in terms of the frequency with which the critical dissolved oxygen deficit of the stream was exceeded.
W68-00382

OPTIMIZATION OF THE HYDRAULIC REGIME OF ACTIVATED SLUDGE SYSTEMS,
Kansas State University, Manhattan.
Larry E. Erickson, and Liang-tseng Fan.
Water Pollution Control Federation Journal, Vol 40, No 3, pp 345-362, Mar 1968. 18 p, 14 fig, 3 tab, 22 ref, 1 append.

Descriptors: *Activated sludge, Operations research, Computer models, Biological treatment, Aeration, Biochemical oxygen demand, Chemical oxygen demand, Cost analysis, Indirect costs, Institutional constraints.
Identifiers: *Direct search technique, Biological kinetics.

The design of activated sludge tanks composed of several completely-mixed aeration tanks connected in series were optimized and compared with the results of a single completely-mixed aeration tank. The optimal solutions were dependent on the flow into the system, the recycle flow, and the mixing within the system. The concentration of organic matter, the organism concentration, and the volume of each aeration tank were the unknown variables. A direct search optimization technique was used to systematically find the optimum. The results of the analysis indicated: (1) the two-aeration-tank activated sludge system required a smaller theoretical volume than the single-type aeration-tank system and (2) the organic nutrient concentration at which the specific growth rate is one-half the maximum growth rate value is a very important variable in design. (Has 22 references.)
W68-00383

STAGE DEVELOPMENT OF WASTEWATER TREATMENT WORKS,
Cornell University, Ithaca, NY.
Walter R. Lynn.
Water Pollution Control Federation Journal, Vol 36, No 6, pp 722-751, June 1964. 30 p, 9 fig, 6 tab, 22 ref.

Descriptors: Wastewater treatment, Linear programming, Capital costs, *Financial analysis, Digital computer, Present value, Interest rate, Economies of scale, Operating costs.
Identifiers: Service charge, *Flow of funds.

A dynamic model was presented to determine the timing and financing of sanitary facilities in response to a growing population. The model incorporated a detailed description of the flow of funds at the times of actual occurrence. A linear programming technique was used to determine the timing of construction, the amount of construction, the funds borrowed, loan repayment schedules, funds invested, and the service charge. Illustrative problems were solved using existing cost data. It was concluded that the model is applicable in planning and evaluating the financing and timing of sanitary engineering construction projects. (Has 22 references.)
W68-00385

A MANAGEMENT MODEL FOR WATER QUALITY CONTROL,
Cornell University, Ithaca, NY.
Charles S. ReVelle, Daniel P. Loucks, and Walter R. Lynn.
Water Pollution Control Federation Journal, Vol 39, No 7, pp 1164-1183, July 1967. 20 p, 12 fig, 2 tab, 15 ref, 2 append.

Descriptors: *Linear programming, Dissolved oxygen, Biochemical oxygen demand, Total cost, *Oxygen sag, Optimum development plans.
Identifiers: Water quality constraints.

A linear programming model was presented to elucidate the mathematical foundations of systems analysis as applied to the problem of determining the minimum cost combination of plant efficiencies necessary to maintain levels of dissolved oxygen in a stream. The constraints of the problem were formed from: (1) the definition of plant efficiencies; (2) inventory equations on biochemical oxygen demand and dissolved oxygen; and (3) quality constraints on dissolved oxygen. A numerical example was solved using artificial data. The procedure illustrated a mathematical programming formulation that: (1) was not an approximation to the oxygen sag equation; (2) easily handled tributaries; (3) specified maximum violations of the dissolved oxygen standards; and (4) was solved by linear programming techniques. An appendix on the spacing of quality constraints was included. (There are 15 references.)
W68-00391

AN ANALYSIS OF THE ECONOMICS OF WASTEWATER TREATMENT,
Northwestern University, Evanston, Ill and Cornell University, Ithaca, NY.
John A. Logan, W. A. Hatfield, and George S. Russell.
Water Pollution Control Federation Journal, Vol 34, No 9, pp 860-882, Sept 1962. 23 p, 12 fig, 6 tab, 10 ref, 1 append.

Descriptors: Total cost, Statistics, Trickling filter, Activated sludge, Capital costs, *Unit costs, Operating costs, Chlorination, *Economic justification, *Performance.

Construction and operating costs for waste treatment plants were obtained from existing plants by means of site visits, and from a series of plants designed for a specific area. Total costs were obtained for primary, high-rate filter, standard-rate filter, and activated sludge plants. Unit costs and efficiency aspects were determined for use in future studies which will be orientated towards finding the minimum cost design. Some of the difficulties in analyzing data from existing plants were: (1) variations in quality and quantity inputs; (2) variations in design criteria; (3) variations in the definitions of each unit process; and (4) local differences in labor, topographic, and geographic conditions.
W68-00392

OPTIMIZATION ANALYSIS FOR BIOLGOCIAL FILTER DESIGN,
Northwestern University, Evanston, Ill.
William S. Galler, and Harold B. Gotaas.
American Society of Civil Engineers, Sanitary Engineering Division Journal, Vol 92, No SA1, Paper 4684, pp 163-182, Feb 1966. 20 p, 6 fig, 3 tab, 12 ref, 4 append.

Descriptors: Linear programming, Biochemical oxygen demand, Capital costs, Unit costs, Operating costs, Digital computer, Operations research, *Recirculated water, Budgeting, *Trickling filters, Ventilation.
Identifiers: Physical constraints.

Linear programming was used in the design of biological filters. The objective was to minimize the costs of operation and construction. Given a waste flow and a biochemical oxygen demand, the analysis selected the radius, depth, and recirculation ratio of each filter. Three temperatures, six biochemical oxygen demands, and flow rates from one to twenty million gallons per day were used as input data. An example problem was solved. The results demonstrated that: (1) variations in design

are related to input conditions; (2) variations in cost parameters within reasonable limits do not effect design variables; and (3) the models can be used for determining more effective designs.
W68-00393

MODELING AND OPTIMIZATION OF STEP AERATION WASTE TREATMENT SYSTEMS,
Kansas State University, Manhattan.
Larry E. Erickson, Y. S. Ho, and L. T. Fan.
Water Pollution Control Federation Journal, Vol 40, No 5, Part 1, pp 717-732, May 1968. 16 p, 6 fig, 2 tab, 5 ref.

Descriptors: *Activated sludge, Operations research, Computer models, Biological treatment, Aeration, Biochemical oxygen demand, Institutional constraints.
Identifiers: *Direct search technique, Biological kinetics.

The effects of the pattern of flow into an activated sludge system and the mixing pattern within the system on the efficiency of the biological process was examined. The four types of systems that were investigated are: (1) a sequence of complete-mixing compartments; (2) a sequence of plug-flow compartments; (3) a complete-mixing compartment followed by a plug-flow compartment; and (4) a plug-flow compartment with continuous distribution of feed along the length of the compartment. Steady-state conditions were assumed. It was required to minimize the volume of the tanks. A direct search optimization technique was used. Under the assumptions of the study, a plug-flow system with continuous feed required the smallest volume for the step aeration system.
W68-00396

ESTUARINE WATER QUALITY MANAGEMENT AND FORECASTING,
USPHS, Delaware Estuary Study, Philadelphia, Pa.
Robert V. Thomann, and Matthew J. Sobel.
American Society of Civil Engineers, Sanitary Engineering Division Journal, Vol 90, No SA5, paper 4116, pp 9-36, Oct 1964. 28p, 8 fig, 1 tab, 11 ref, 2 append.

Descriptors: *Time series analysis, Dissolved oxygen, Biochemical oxygen demand, Total cost, Oxygen sag, *Optimum development plans, Wastewater treatment, Fourier analysis, Digital computer.
Identifiers: Delaware Estuary, Water quality constraints.

Time series and mathematical programming techniques were used for forecasting dissolved oxygen and formulating the objective function and constraints for the optimal management of waste inputs. Dissolved oxygen data from the Delaware Estuary were used. Illustrative problems were structured to show the managerial problems that can be solved. The extent of the forecasting scheme depends upon the knowledge of the parameters used in the transfer function, and the waste input data. Difficulties that are associated with attempts to control transient fluctuations of quality were examined. Salinity intrusion profiles were used to illustrate the transient control problems.
W68-00398

STANTON V TRUSTEES OF ST JOSEPH'S COLLEGE (LEGAL JURISDICTION OF DISCHARGE OF SEWAGE INTO A NON-NAVIGABLE STREAM).

233 A 2d 718 (Me 1967).

Descriptors: Water pollution control, *Pollution abatement, State governments, Administrative agencies, *Non-navigable waters, *Maine, *Remedies, Riparian waters, Riparian rights, Eminent domain, Natural flow doctrine, Sewerage.

This was a complaint by riparian owners along a small nonnavigable brook to enjoin discharge of sewage into the brook from a proposed college dormitory. The water improvement commission had issued the college a license to discharge the sewage. Plaintiffs had opposed the issuance and appealed through administrative channels provided by Statute. Subsequently plaintiffs voluntarily dismissed the appeal and commenced this action. The lower court dismissed for failure to exhaust administrative remedies. This court reversed holding that the statute creating the commission was in derogation of the common-law doctrine that upper owners may not unreasonably divert, obstruct, or pollute streams, and that statutes in derogation of the common law must be strictly construed. The court found that although the statute authorized the commission to determine when sewage discharge was against the public interest, it had no power to determine private rights. Plaintiffs had alleged grounds for relief beyond the jurisdiction of the commission, so that it would be futile for them to complete the administrative appeal and were entitled to have their alleged private rights determined against the proposed use.
W68-00442

THE RELATIONSHIP OF WASTE HANDLING PRACTICE TO PESTICIDE RESIDUE LEVELS AND INVERTEBRATE ECOLOGY,
Michigan State University.
Matthew Zabik.
Annual Progress Report of Project to the Office of Water Resources Research, Dept. of the Interior, 1968.

Descriptors: Pesticides, Water pollution, Waste treatment.
Identifiers: DDT, Mussels, Red Cedar River.

In order to determine the contribution of urban and rural areas to the pesticide contamination of the watershed of Michigan rivers and streams, soil suspended matter and water samples from the Red Cedar River have been analyzed. Various organisms have been evaluated to find possible biological indicators of pesticide contamination; of these, fresh water mussels have been proven to be excellent biological indicators in lotic environments and their use has been employed in the Red Cedar River. Results have implicated urban areas as the primary source of pesticide contamination. These results point out the need for constant surveillance of our rivers and streams for pesticide contamination with more emphasis on the amount contributed by our urban and suburban areas. Another important fact is that the levels of pesticide in the Red Cedar and Grand Rivers are of such a magnitude that they have had and will continue to have a drastic influence on their ecology.
W68-00492

A MODEL FOR QUANTIFYING FLOW AUGMENTATION BENEFITS,
U of Florida, Gainesville.
Edwin E. Pyatt.
A Progress Report to FWPCA concerning Research Grant WP-01050-02, Engineering and Industrial Experiment Station, University of Florida, 31 May 1968, 43 p, 8 fig, 1 tab, 18 ref.

Descriptors: Abatement, Administrative decisions, Alternative costs, Annual benefits, Annual costs, Computer models, Conjunctive use, *Dissolved oxygen, Economic efficiency, *Flow augmentation, Hydrologic data, Impoundments, Management, *Mathematical models, *Methodology, Multiple-purpose reservoirs, Municipal wastes, Optimization, Organic loading.
Identifiers: Oxygen sag, Reservoir operation, Stochastic processes, Synthetic hydrology, *Systems analysis, Waste dilution, *Water quality control.

The 'Low Flow Augmentation Project', designated WP-01050-02, has as its objective the development of a generalized mathematical model of a typical river basin, which is susceptible to manipulation such that it is possible to assess functional responses of sewage treatment levels and flow augmentation conjunctively utilized to achieve specified levels of stream water quality. To this end, the project has been subdivided into six avenues of inquiry. The first avenue has to do with the formulation of predictive equations for 'routing' assimilative capacity into, through and out of reservoirs. This formulation, in a sense, is to be a stochastic version--stochastic in terms of both runoff and temperature--of extant equations, such as those of Dobbins. The second phase was initiated in early Spring 1967, when Mr. R. D. G. Pyne undertook a study of 'Cost Curves of Sewage Treatment for Low Flow Augmentation.' The results were published as a thesis which was submitted to the Graduate School of the University of Florida in August 1967. As a counterpart to sewage treatment costs, generalized cost curves for impounding water for flow augmentation are essential. Mr. A. Perex, a candidate for the M.S.E. degree and a Graduate Research Assistant on the Low Flow Project, is undertaking a small-scale simulation which will yield the desired information. The last three phases are currently being pursued.
W68-00502

TRANSPORT OF ORGANIC AND RADIOACTIVE WASTES,
Engineering Science Inc, Oakland, Calif; Tulane University, New Orleans, La; University of Texas, Austin.
Neal E. Armstrong, Larry W. Canter, and Earnest F. Gloyna.
Water and Wastes Eng, Vol 5, No 7, pp 54-56, July 1968. 3 p, 6 fig, 3 ref.

Descriptors: *Organic wastes, *Radioactive wastes, *Research equipment, Waste dilution, Tracers, Dye releases, Path of pollutants, Streamflow, River flow, *Artificial watercourses.
Identifiers: *Research (Water), University of Texas, *Waste transport research.

Current work with a model river constructed to study waste transport is described in general terms. Results are presented for 1 dye release and 2 radioactive tracer releases. The model river is 200 ft long, 2.5 ft wide, and 2.0 ft deep. It is divided into 2 equal channels by a 2 ft partition along the centerline. Slopes can be varied from 0 to 0.006 ft per ft. The flow is measured by 2 v-notch weirs and may be varied to a maximum of 1.73 cfs. Dissolved oxygen, pH, temperature, sunlight, and oxidation-reduction potential may be measured and electrically recorded.
W68-00561

NOR ANY DROP TO DRINK: PUBLIC REGULATION OF WATER QUALITY PART II: INTERSTATE ARRANGEMENTS FOR POLLUTION CONTROL,
U of Iowa College of Law, Iowa City.
N. William Hines.
Iowa L Rev Vol 52, No 3 pp 432-457 Dec 1966. 25 p, 127 ref.

Descriptors: Water pollution, *Water pollution control, Water law, State governments, Judicial decisions, Administrative agencies, Federal government, Delaware River Basin Commission, *Interstate commissions, *Interstate compacts, Colorado River Compact, Interstate rivers, *River basin commissions, Water quality control, Pollution abatement.

The purpose of this article is to explore the possibilities for interstate cooperation in the area of water quality improvement. In the past, differences between states as to polluted water have been largely reduced by cooperative arrangements. Regional executive agreements have been most helpful on the interstate level. These agreements often commence with reciprocal state legislation. The author envisions the interstate compact as a possible device for pollution control joined with an in-

terstate administrative agency. A discussion of several interstate agencies is included. The major drawback in the compact approach, however, is the consent requirement. The compact must be approved by the states, the federal legislature, and the President. Congress has taken a more active position recently and the compacts have the force of federal law. In terms of success, the agencies have room for a great deal of improvement. This is due in part to the minimal standards established by the agencies. They are also hampered by insufficient enforcement powers and financial frameworks. The author also advocates interstate river basin planning. It is emphasized, however, that short term abatement programs are of primary importance.
W68-00621

CITY OF BOWIE V WASHINGTON SUBURBAN SANITARY COMM'N (JURISDICTION OF SEWERAGE SYSTEM ACROSS MUNICIPAL BOUNDARIES).
2 Md App 183, 241 A 2d 396-400 (1968).

Descriptors: *Maryland, Municipal wastes, Sewers, Cities, Judicial decisions, Legal aspects, Local governments, Political aspects, Construction.
Identifiers: Washington Suburban Sanitary Commission.

The city of Bowie, Maryland opposed the construction of a municipal sewerage system by the Washington Suburban Sanitary Commission because the Maryland Code provided that no local law conferring special powers on any commission shall be construed to divest any municipal corporation exercising the same powers of its right to continue the exercise of such powers. However, it was held that a subsequent provision of the Maryland Code, which stated that no municipal corporation shall impair in any respect the powers relating to sanitation, including sewer, water, and similar facilities of the Washington Suburban Sanitary Commission, was controlling. The statute creating the Washington Suburban Sanitary Commission is not a local law because it covers large areas of two counties adjoining a metropolis, and under the Maryland Constitution applicability of a law to two or more geographical subdivisions of the state prevents that law from being deemed local.
W68-00630

CONSERVATION OF POWER AND WATER RESOURCES - GRANTS FOR WATER POLLUTION CONTROL - PUBLIC HEARINGS UNDER THE FEDERAL WATER POLLUTION CONTROL ACT.
Office of the Federal Register, Washington, DC.

Federal Register, Vol 31, No 94, pp 7114-7128, May 14, 1966. 15 p.

Descriptors: *Water pollution control, *Grants, *Administrative agencies, Administrative decisions, Adjudication procedure, Federal government, Legal aspects, Water law, Treatment facilities, Construction costs, Sewerage, Research and development.
Identifiers: *Water Pollution Control Act, Department of the Interior, *Hearings.

Rules and regulations dealing with grants for water pollution control, made pursuant to the Federal Water Pollution Control Act, are set forth in Part 601. Included within the scope of the grants are demonstration projects for the control of discharges from stormwater or combined sewer systems, construction of treatment works, research, training, and awards for research fellowships. Detailed rules and regulations for each of these areas are given, including formulas for allotments to states and interstate water pollution agencies. Part 606 presents rules and regulations for public hearings held under the Federal Water Pollution Act, covering areas from publication of notice to parties to evidence.
W68-00640

INSECTICIDE ADSORPTION BY POND SEDIMENTS AND WATERSHED SOILS,
Purdue University.
Norman Larry Meyers.
M.S. Thesis, pp 1-99, Aug 1968. 99 p, 15 fig, 14 tab, 91 ref.

Descriptors: *Adsorption, *Insecticides, *Isotherm, Soils, Bottom sediments, X-ray diffraction, Clay.
Identifiers: Malathion, Phorate, Carbaryl, Watershed soils, Pond sediments, Specific surface, Infrared spectroscopy.

Pond sediments and watershed soils were used as adsorbents to study malathion, phorate, and carbaryl adsorption. X-ray diffraction techniques confirmed the presence of vermiculite, mica, and kaolinite in both the sediments and soil. Infrared spectroscopy revealed a slight kaolinite enrichment in the pond sediment. Textural analysis showed a higher clay content in the sediment than in the watershed soil. The cation exchange of the clay fraction was 42 meq/100 gm for the soil and 37 meq/100 gm for the sediment. The specific surface of the clay fraction was 297 square meters/gm for the soil and 241 square meters/gm for the sediment. Adsorption was found to obey the fundamental Freundlich isothermal relationship. The amount of adsorption for the insecticides was in the order: malathion greater than carbaryl greater than phorate. Adsorption of malathion and carbaryl was greater on the pond sediment than on the soil probably due to the higher clay content of the sediment. Adsorption of phorate was not influenced by the higher clay content of the sediment.
W68-00653

06. WATER RESOURCES PLANNING

6A. Techniques OF Planning

TECHNIQUES OF WATER RESOURCES PLANNING, WATER LAW, AND INSTITUTIONS,
Water Resources Council, Washington, DC.
Henry P. Caulfield, Jr.
Water Resources Bull, Vol 4, No 1, pp 21-36, Mar 1968. 16 p.

Descriptors: *Water resources planning, Governments, Coordination, *Decision making, *Institutions, Legislation, Economic efficiency, Management, Methodology, Programs, *Water law, Social aspects, Water Resources Research Act, Administrative agencies, Regulation, Analytical techniques, Economics, Research facilities, *River basin commissions.
Identifiers: Flood Control Act, *Governmental interrelations, Urban planning, Water and related resources, Evaluation research.

The 'state of the art' of techniques relating to institutions, water law, and water resources planning at Federal, State, and local governmental levels is described and outlined with respect to interrelating these levels in planning and action programs. Legislation leading to the Water Resources Research Act of 1964 and the Planning Act of 1965 is reviewed and related to techniques for relieving 'the most neglected area in the present program.' The need is stressed for better coordination in all areas-- private enterprise and government--engaged in policy proposals, planning criteria, methods, and practices that involve water research. Such disciplines as engineering, political science, law, ecology, history, forestry, soil science, land and urban planning are essential in research aimed at advancements in policy, planning, and institutions. They must work separately as well as in interdisciplinary groups. Officials at all levels of government are faced with decision making based upon scientific truths and basic norms and subsidiary criteria; the latter includes value judgements believed valid that often have ethical and esthetic elements.
W68-00334

DYNAMIC PROGRAMMING IN WATER RESOURCES DEVELOPMENT,
Technion - Israel Institute of Technology, Haifa.
Nathan Buras.
Advances in Hydroscience, Vol 3, pp 367-412, 1966. 46 p, 12 fig, 5 tab, 68 ref.

Descriptors: *Dynamic programming, Linear programming, Simulation analysis, *Water resources development, Planning, Monte Carlo method, Markov process, Stochastic processes, *Optimization, Multi-purpose project, Conjunctive use, Water storage, Hydroelectric power.
Identifiers: Coastal aquifer, Recursive relationship.

A review of some of the applications of mathematical models in water resources beginning with Rippl's work in 1883, were presented. A linear programming model of a river basin system, presented elsewhere, was restructured, and its limitation was discussed. The application of simulation was also briefly discussed. Most of the article was devoted to dynamic programming. General descriptions of the hydrologic, economic, and other problems in water resources were included. The recurrence relationships of multi-stage decision processes with one and more state variables were structured, both for deterministic and stochastic conditions. The applications of this model to water storage, conjunctive use, coastal aquifers, and hydroelectric power generation were presented. Digital computer solutions for two examples were given. Some other applications are briefly mentioned.
W68-00362

THE OPTIMAL YIELD OF AN AQUIFER,
Technion, Israel Institute of Technology, Haifa.
J. Bear, and O. Levin.
Int Ass of Sci Hydrol, Symp of Haifa, Publication No 72, pp 401-412, 19-26 March 1967. 12 p, 5 fig.

Descriptors: *Safe yield, *Management, *Optimization, Dynamic programming, *Aquifer, Recharge, Water source, Water resources, Planning, *Mathematical model, Demand, Marginal benefits.
Identifiers: Cost function, Sequential decision process.

New criteria was presented to replace the safe yield approach to ground water management. The dynamic nature of the ground water aquifer and its relation to the total water resource system was shown to be suited for the application of optimization techniques. A discrete dynamic programming model was presented for a homogeneous phreatic aquifer of finite real extent, with probabilistic inputs. The objective function was obtained by comparing immediate marginal net benefits, derived from concave demand and cost functions.
W68-00364

APPLICATION OF SYSTEMS ANALYSIS TO PROBLEMS IN WATER AND WASTE WATER TREATMENT,
Cornell Univ., Ithaca, NY.
Walter R. Lynn.
J Amer Water Works Ass, Vol 58, No 6, pp 651-656, June 1966. 6 p, 4 ref.

Descriptors: Biochemical oxygen demand, Computer programs, Constraints, Digital computers, Distribution system, *Mathematical models, Marginal costs, Marginal benefits, Operations research, Optimization, *Simulation analysis, *Systems analysis, Water resources development, Stability.
Identifiers: Sensitivity analysis.

A general discussion of the application of systems analysis techniques to water resources problems was presented. A system was defined, and the design requirements of the total systems approach, as compared to the traditional component approach were given. The important features of the design procedure were enumerated as follows: (1)

formulate mathematically the component interactions; (2) do a sensitivity analysis; (3) determine the system stability for various inputs; (4) optimize with respect to preselected criteria; (5) predict performance; and (6) test by means of a mathematical or prototype. An illustration of mathematical programming applied to the minimization of water supply costs for a community was given. The use of the models in supplying the marginal costs and benefits of various alternatives, in addition to the optimal solutions, was emphasized, especially regarding their aid in the making of policy decisions. Simulation studies by the Harvard Water Resources Program and a water quality study at Cornell University were briefly described.
W68-00365

SCHEDULING THE USE OF WATER POWER,
Stanford Univ., Stanford, Calif.
John Gessford.
Manage Sci, Vol 5, No 2, pp 179-191, Jan 1959. 13 p, 5 fig, 7 ref.

Descriptors: Economic efficiency, Electric power demand, Hydraulic design, *Hydroelectric power, Hydrologic data, *Linear programming, Mathematical models, Reservoir design, *Reservoir operation, *Scheduling, Water policy, Water management (Applied).
Identifiers: Deterministic streamflow, Inventory model.

A probabilistic inventory model with a linear cost function was structured to find the optimal operation rules of a hydroelectric development. The following assumptions were made: (1) unlimited reservoir and turbine capacities; (2) inflow in one time period not available for power generation until the next period; and (3) no evaporation losses. The optimal water utilization policy was described and shown schematically. An example illustrated the use of the model. The effect of a convex cost function on the optimal policy was discussed, and it was concluded that all available water should be used in the immediate future if such a function applied. The effect of deterministic future flows on the optimal policy was studied. In this study it was assumed that (1) power demand, reservoir inflow, and turbine flow were given as functions of time; (2) power generation did not vary with changes in the reservoir level; and (3) power obtainable was limited by turbine and reservoir capacities. It was found that the optimal policy remained unchanged.
W68-00367

QUEUING THEORY AND SIMULATION IN RESERVOIR DESIGN,
California Univ., Los Angeles.
Myron B. Fiering.
Amer Soc Civil Eng Proc, Vol 87, No HY 6, pp 39-69, Nov 1961. 31 p, 11 fig, 15 tab, 5 ref, 1 append.

Descriptors: Correlation analysis, Digital computers, Distribution pattern, Estimated benefits, Frequency analysis, Hydrologic cycle, Least squares method, Regression analysis, *Reservoir design, Reservoir operation, *Queuing theory, *Simulation analysis, *Synthetic hydrology, Monte Carlo Method, Probability.
Identifiers: Operating rule, Probability distribution, Serial correlation, Present value, Flow charts.

The theory of queus and Monte Carlo techniques were applied to the problem of selecting the optimal design of a single multi-purpose reservoir. Simulation of the reservoir system response to hydrologic inflows was performed on a large-scale electronic digital computer. Draft probabilities and economic benefits were computed and compared when long synthetic records were routed through the proposed designs. Synthetic hydrology was produced for a 500-year sequence. The annual draft requirements were evaluated in accordance with a given operating rule for different values of reservoir capacity and normal draft levels. Rounding to the nearest integer values, tables of draft probabilities were prepared which were used to compute the present values of expected net benefits for the various alternatives. It was found that increasing serial correlation tended to depress the value of net benefits corresponding to the optimal selection of system design. A numerical example and a flow chart of the computer program were given.
W68-00368

OPTIMIZATION OF RESOURCE ALLOCATION IN PROJECT PLANNING,
Mihailo Pupin Institute for Automation and Telecommunications, Belgrade, Yugoslavia.
Radivoj Petrovic.
Oper Res, J Oper Res Soc Amer, Vol 16, No 3, pp 559-568, May-June 1968. 10 p, 4 fig, 6 ref.

Descriptors: Approximation method, Computer programs, Digital computers, *Dynamic programming, Economic efficiency, Estimated costs, Future planning (Projected), *Optimization, *Project planning, *Resource allocation, Management, Control, Coordination, Scheduling.
Identifiers: Subproject programming.

Discrete dynamic programming was used to determine the optimum resource allocation in a project plan. It was assumed that the technological ordering of activities in a project would be defined by a project graph. The predecessor-successor relations of activities were mapped into a set of transformations, where the state variables were the amounts of work required to complete the activities. The resources allocated to each activity were considered as decision variables, which were constrained when resources were limited. Thus the project execution was considered as a discrete multistage decision process with the associated objective function. It was shown that the high dimensionality of the functional equations that appear in the program can be overcome by means of (a) subproject programming; (b) two-level concept of management control evaluation; and (c) approximation in policy space.
W68-00369

OPTIMIZATION TECHNIQUES FOR HYDROLOGIC ENGINEERING,
Corps of Engineers, Sacramento, Calif.
Leo R. Beard.
Water Resources Res, Vol 3, No 3, pp 809-815, 3rd Quart 1967. 7 p, 1 fig, 9 ref.

Descriptors: Dynamic programming, Linear programming, *Optimization, Hydrologic data, *Approximation method, Estimating, Numerical analysis, Unit hydrographs, Water resources, *Digital computers, Project planning, Synthetic hydrology, *Simulation analysis, Value engineering, Planning.
Identifiers: *Univariate method, *Gradient methods, Steepest ascent, *Convergence technique, Objective function.

A brief introduction and generalized discussion of optimization procedures presently used in the solution of complex water resources design and operation problems was made. Linear programming was referenced. Dynamic programming techniques were briefly described and referenced. The main emphasis was on the gradient method of optimization (or method of successive approximations). The steps followed in this Univariate Method of optimization were: (1) assume reasonable first approximation of system variables; (2) compute objective function; (3) in a systematic manner vary magnitude of system variables to obtain convergence of the objective function to its optimum value. The convergence technique, and its similarity to the Method of Steepest Descent were discussed. Methods for avoiding suboptimum solutions and interrelated system variables were given. A short illustrative example of the Univariate Optimization Technique used in devising an automated unit-hydrograph and loss-rate analysis was presented.
W68-00370

GROUNDWATER MANAGEMENT UNDER QUADRATIC CRITERION FUNCTIONS,
Missouri Univ., Columbia.
Oscar R. Burt.
Water Resources Res, Vol 3, No 3, pp 673-682, Third Quart 1967. 10 p, 8 ref.

Descriptors: *Groundwater, *Management, Decision making, Stochastic processes, Optimization, Natural recharge, Water supply, Pumping, Operating costs.
Identifiers: Quadratic function, Stochastic programming, Diminishing returns.

General stochastic programming was used to determine an optimal policy for groundwater utilization. It was proved that an optimal policy for temporal allocation of groundwater was dependent on only the first moment of the probability distribution of recharge, if the annual net output of the basin was quadratic and if a positive equilibrium stock existed without invoking inequality constraints. The net output function consisted of (1) rate of use and (2) quantity of stocks. Optimal decision rules under a quadratic criterion function were shown to be relatively simple, even when stochastic natural recharge was considered. A brief analysis of the probability distribution of groundwater stocks was included. Some consideration was given to approximately optimal policies when inequality constraints on rate of use were binding.
W68-00374

MATHEMATICAL SIMULATIONS FOR BETTER AQUIFER MANAGEMENT,
Colorado State Univ, Fort Collins.
M. W. Bittinger, H. R. Duke, and R. A. Longenbaugh.
Int Ass of Sci Hydrol, Symp of Haifa, Publication No 72, pp 509-519, 19-26 March 1967. 11 p, 4 fig, 13 ref.

Descriptors: *Simulation analysis, *Mathematical models, Aquifers, Conjunctive use, Management, Operations, Optimization, Digital computers.
Identifiers: Arkansas River Valley, Colorado, Wellton-Mohawk aquifer, Arizona.

A mathematical model and computer analysis techniques were presented to allow for consideration of: (1) varied aquifer hydraulic and geometric characteristics; (2) highly variable pumping patterns in time and space; (3) imperfectly connected bodies of surface water; and (4) non-deterministic natural recharge. For calibration the model was programmed to simulate an historic period, for which both groundwater level and stream flow records are available. Legal and economic constraints may be programmed into the model so as to arrive at optimal decisions based upon these factors, as well as upon physical feasibility. Applications to two basins were briefly described.
W68-00379

MATHEMATICAL MODELS FOR INDUSTRIAL WASTE DISPOSAL SYSTEMS,
Harvard University, Cambridge, Mass.
David H. Moreau.
Thesis, Harvard University, Cambridge, Mass, Feb 1967. 166 p, 15 fig, 16 tab, 62 ref, 5 append.

Descriptors: Linear programming, *Pulp wastes, Pulp and paper industry, Disposal, Operations research, Waste assimilation capacity, Capital costs, Operating costs, Recirculated water, Digital computer.
Identifiers: *Nonlinear programming, *Effluent storage, Present value, Uncertainty, Steady state conditions, *Fiber recovery, Expected value.

A mathematical representation of a steady-state industrial waste disposal system was presented. The receiving water was assumed to have seasonal fluctuations of waste assimilative capacity. The system received inputs at an essentially constant rate. A hypothetical system for the recovery and treatment of a typical unbleached kraft pulp and paper mill waste was solved. An iterative technique was used

for solving the nonlinear programming problem. Linear programming was used for examining binding constraints. In general, the results: (1) supported engineering design practice; (2) demonstrated the use of the model; and (3) identified areas for additional study. More specific results were obtained for detention times in primary treatment units and recovery units. Reliability of input parameters was examined. (There are 62 references.)
W68-00381

A THREE-DIMENSIONAL OPTIMIZATION PROBLEM IN WATER-RESOURCES ENGINEERING,
Technion, Israel Institute of Technology, Haifa.
Nathan Buras.
Oper Res Quart, Oper Res Soc, Vol 16, No 4, pp 419-428, Dec 1965. 11 p, 4 fig, 1 tab.

Descriptors: *Reservoir storage, *Optimization, Operation, *Dynamic programming, Digital computer, Irrigation, Aquifer, Stochastic process.
Identifiers: Algarithm, Expected return, *Benefit function, Steady state, Sequential decision process.

Discrete probabilistic dynamic programming was applied to solve the optimal operating policy of two reservoirs in series. Benefits were derived from irrigation. Concave benefit functions were assumed. An hypothetical example was solved on IBM 7090 digital computer, and the results were presented in tabular and graphical forms. The author indicated that the policy asymptotically approached a steady state. He also stated that such a problem taxes the capacity of existing digital computers.
W68-00386

OPTIMIZATION OF THE OPERATION OF A MULTIPLE-PURPOSE RESERVOIR BY DYNAMIC PROGRAMMING,
Calif. Univ., Los Angeles.
Warren A. Hall, William S. Butcher, and Austin Esogbue.
Water Resources Res, Vol 4, No 3, pp 471-477, June 1968. 7 p, 3 fig, 4 ref.

Descriptors: *Optimization, *Multiple purpose reservoirs, *Dynamic programming, Water resources, Planning, Hydroelectric power, Flood control, Return, Mathematical model, Computer program.
Identifiers: Shasta Dam, Critical period hydrology, Off peak energy.

Discrete dynamic programming was used to determine an operating policy for a system producing hydroelectric power and water supplies. The policy objective was to determine the set of releases that maximized the total return, subject to release, energy generation, and storage constraints. The policy was based on the storage volume, price schedule, and sequence of past inflows. A flow chart of the digital computer program was presented. The computational procedures developed were applied to the Shasta Dam on the Sacramento River. Computational time required five seconds for a one-year planning period and eighty-three seconds for a seven-year planning period.
W68-00387

ANCLOTE RIVER BASIN PILOT STUDY,
Division of Water Resources and Conservation, State Board of Conservation, Tallahassee, Florida.
Frank C. Mohler.
Anclote River Basin Pilot Study, pp 1-29, Feb 1967. 29 p, 15 fig, 8 tab.

Descriptors: Feasibility studies, *Florida, Future planning (Projected), Multiple purpose projects, *Project planning, *River basin development, Water resources development, Watershed management, *Data collections, River basins.
Identifiers: *Anclote River Basin.

The Anclote River Basin is located in Pasco and Pinellas Counties in Florida. The Anclote Basin Study report is the compilation of available water resources and related resource data for the area. It was prepared as a pilot study to determine the amount of additional data collection that would be necessary before sufficient data would be available for the preparation of a comprehensive plan for development and best use of the water and related resources of the basin. Information was collected from various state and federal agencies and from limited field studies by personnel of the Division of Water Resources and Conservation. The report summarizes the present data and points out where additional data are needed. It suggests that the most efficient way to collect the needed data is through a basin-by-basin inventory on a state-wide basis. This would make possible the preparation of a comprehensive state water plan.
W68-00402

INTERDEPENDENCE AND ADDITIVITY IN MULTIVARIATE, UNIDIMENSIONAL EXPECTED UTILITY THEORY,
Research Analysis Corporation, McLean, Virginia.
Peter C. Fishburn.
Inter Econ Rev, Vol 8, No 3, pp 335-342, Oct, 1967. 8 p, 7 ref.

Descriptors: *Distribution, Probability.
Identifiers: Real-valued, *Expected utility theory, *Additivity theorem, *Interdependencies, Transformations, Subspace, Coordinates.

This paper combines three recurring themes of utility theory: interdependence among coordinates in a multidimensional pure-prospect space, additive utilities, and expected utilities. The main result of the paper is as follows. Given a real-valued, expected utility function on a set of probability distributions over a multidimensional pure-prospect space, let the space be 'separated' into lower-dimensionality subspaces, some of which may overlap. Then the utility, as given, for any probability distribution can be written as the sum of utilities assigned to its marginal probability distributions over the subspaces if and only if the following condition holds. If, for any given sub-space in the 'separation', two distributions have the same marginal distribution over the subspace, then neither distribution is preferred to the other.
W68-00647

6B. Evaluation Process

PRESERVATION VALUES IN RIVER BASIN PLANNING,
Izaak Walton League of America.
R. Tippy.
Natur Resources J, Vol 8, No 2, pp 259-278, Apr 1968. 20 p, 2 tab.

Descriptors: *Planning, Management, Project planning, Economic justification, Estimated benefits, Estimated costs, *Multiple-purpose projects, Legislation, *River basin development, Federal government, Wild rivers, Scenery, Missouri River, *Dams, Recreation, Flood control.
Identifiers: *River basin planning, *Alternatives, Corps of Engineers, Federal Power Commission, Bureau of Reclamation.

River basin planning is defined, and the activities of and relationships between various governmental agencies active in river basin management and development are explained. Planning is in part a matter of making reasoned choices between potential uses of a river when the uses conflict. The conflicts increase because demand for preservation values and benefits of development are both increasing. The promise of comprehensive planning is that of putting a team of unbiased individuals in a position to survey a basin and indicate how each value could be maximized. Actual experience has been less than ideal so that planning often seems to cause conflicts; often comprehensive planning has meant only compreidnsive development. The types of decisions made and the methods of arriving at them are given for the Corps of Engineers, the Federal Power Commission, and the Bureau of Reclamation. The Wild Rivers studies are summarized, present legislature proposals are outlined, and the history of the Upper Missouri Joint Study is presented in some detail.
W68-00345

AN APPROACH TO MANAGEMENT AND OPTIMAL UTILIZATION OF AQUIFERS,
Technion - Israel Institute of Technology, Haifa.
Jacob Bear, and O. Levin.
Amer Water Resources Ass, Proc of the Second Annual Amer Water Resources Conf, pp 200-212, 1966. 12 p, 4 fig.

Descriptors: *Safe yield, *Management, *Optimization, Dynamic programming, Recharge, *Aquifer, Water source, Water resources, Planning, *Mathematical model, Demand, Marginal benefits.
Identifiers: Cost function, *Sequential decision process.

New criteria was presented to replace the safe yield approach to groundwater management. The dynamic nature of the ground water aquifer and its relation to the total water resource system was shown to be suited for the application of optimization techniques. A discrete dynamic programming model was presented for a homogeneous phreatic aquifer of finite real extent, with probabilistic inputs. The objective function was obtained by comparing immediate marginal net benefits, derived from concave demand and cost functions.
W68-00363

POLICY MODELS FOR OPERATING WATER RESOURCE SYSTEMS,
Cornell University, Ithaca, NY.
Daniel P. Loucks.
Amer Water Resource Assoc, Proc No 2, pp 232-246, Nov 20-22 1966. 15 p, 4 fig, 4 ref.

Descriptors: *Linear programming, *Reservoir operation, Estimated benefits, Operating costs, Regression analysis, Hydrologic data, Operations research, *River systems, Economic efficiency, Formulation, Consumptive use, *Sequential generation, Future planning (Projected), Water allocation (Policy).
Identifiers: *Operating policies, *Deterministic models, Target allocations, Expected values, Constraints.

Sequential decision models for determining river system operating policies were developed. The deterministic models were based on expected values or best estimates of future inflows and economic conditions in the river system. The solution specifies the reservoir releases required to satisfy the quantitative requirements of the present period subject to best estimates of future requirements and conditions. After each period the hydrologic and economic estimates were revised and the model was solved again using the updated estimates. The models which can be solved using standard linear programming techniques, minimize the losses resulting from missing the various target allocations in the system. The derivation of the convex loss functions and their segmentation into pricewise linear portions was discussed. A simplified theoretical river system was presented and the constraint equations for this system were derived. Explicitly considering the consequences various operating policies should result in policy improvement and more efficient utilization of water resources.
W68-00366

ON THE EFFICIENT USE OF HIGH ASWAN DAM FOR HYDROPOWER AND IRRIGATION,
Harvard Univ, Cambridge, Mass.
Harold A. Thomas, Jr., and Roger Revelle.
Manage Sci, Vol 12, No 8, series B, pp B-296-311, Apr 1966. 16 p, 2 fig, 5 tab, 8 ref.

Descriptors: Digital computers, Economic efficiency, Electric power demand, Agriculture, Distribution patterns, Future planning (Projected), *Irrigation, *Linear programming, Mathematical models, *Reservoir operation, *Multi-purpose reservoirs, Water allocation (Policy), *Hydroelectric power.
Identifiers: *Agricultural demands, *High Aswan Dam, United Arab Republic.

Linear programming techniques were used to determine qualitatively and quantitatively the relations between agricultural and power uses of the waters released from the High Aswan Dam. The complementarity between agricultural and power uses was discussed and mathematically analyzed (using linear programming). The results, calculated on a 7094 IBM computer, showed the optimum power releases over a twelve-month period for seven levels of irrigation targets. A linear programming problem was formulated to find the proper ranking of the many alternative operating schemes. The use of a sensitivity analysis to determine the effect of a non-optimal but expedient solution was discussed. The use of downstream storage to achieve a higher degree of complementarity between agricultural and power uses was studied. Refinements necessary to achieve a more realistic model were mentioned. It was concluded that effective management could result in high efficiencies, but that a more comprehensive model containing more input data should be used.
W68-00372

CONJUNCTIVE OPERATION OF DAMS AND AQUIFERS,
Israel Inst of Tech, Haifa, Israel.
Nathan Buras.
Amer Soc Civil Eng Proc, Vol 89, No HY 6, pp 111-131, Nov 1963. 21 p, 4 fig, 3 tab, 18 ref, 3 append.

Descriptors: *Dynamic programming, *Conjunctive use, Aquifers, Groundwater recharge, Reservoir operation, Hydrologic data, Synthetic hydrology, Estimated benefits, Surface-groundwater relationships, Irrigation design, Irrigation efficiency, Optimum development plans, Design criteria, Discount rate, Computer programs.
Identifiers: *Operating policies, Present value, Santa Ana River California, Steady state solutions.

Dynamic programming was used to find the optimum method of operation of a surface reservoir and a groundwater aquifer. The problems were to find the size of the dam and recharge facilities, the areas to be irrigated, and the optimum operating policies that specified reservoir releases and pumpages from the aquifer. The operating policy problem was solved analytically using dynamic programming on varying sizes of design criteria and serviced areas. A simplified one reservoir-one aquifer system with independent irrigation areas was described. All design criteria, cost and benefit functions, interest rates and probabilistic hydrologic data were assumed known. An illustrative example using benefit functions from the literature and hydrologic data for the Santa Ana River in California was presented. A computer program for the IBM 7090 digital computer gave optimal or 'steady state' solutions which were presented in tabular form. It was found that the optimal operating policy reached a 'steady state' for processes of eight stages of duration. (Has 18 references.)
W68-00373

THE DYNAMIC PROGRAMMING APPROACH TO WATER RESOURCES DEVELOPMENT,
Calif. Univ., Los Angeles.
Warren A. Hall, and Nathan Buras.
J of Geophys Res, Amer Geophys Union, Vol 66, No 1, pp 517-520, Feb 1961. 4 p, 11 ref.

Descriptors: *Dynamic programming, *Water resources development, Benefits, Demands, Reservoir sites, Water users, Optimization, Reservoir storage.

Dynamic programming was applied to the development of water resources. A series of similar mathematical models were structured for determining the sites, allocations, uses, and benefits derived from water resources. The objective was to maximize net benefits derived from water resources utilization. In order to be able to apply these models it was required that the solution of each model be independent of the solutions of all the other models.
W68-00375

PLANNED UTILIZATION OF GROUNDWATER BASINS: STUDIES CONDUCTED IN SOUTHERN CALIFORNIA,
The Resources Agency, State of California.
Y. D. Chun, Ernest M. Weber, and Kiyoshi W. Mido.
Int Ass of Sci Hydrol, Symp of Haifa, Publication No 72, pp 426-434, 19-26 March 1967. 9 p, 2 fig.

Descriptors: *Groundwater basins, Water supply, Mathematical model, Digital computer, Management, *Simulation analysis, Conjunctive use.

A general description of a simulation scheme that had been initiated by the State of California for planned utilization of ground water basins was presented. Preceding the simulation model, a thorough hydrologic and geologic investigation was conducted, and a mathematical model developed. The model was calibrated and solved on a general purpose digital computer. Two ground water basins were investigated with the aid of this model. Economic and management information, as well as physical information, were obtained using this model. This technique is adaptable to any locality.
W68-00376

SYSTEMS ENGINEERING AND AQUIFER MANAGEMENT,
Technion Israel Institute of Technology, Haifa.
Nathan Buras.
Int Ass of Sci Hydrol, Symp of Haifa, Publication No 72, pp 466-473, 19-26 March 1967. 8 p, 2 fig, 33 ref.

Descriptors: *Systems analysis, *Aquifers, Management, Operations, Operations research, Quality control, Optimization, Conjunctive use.
Identifiers: Southern California, Indus Valley, Israel.

A general discussion of systems engineering and their application to water resources was presented. The techniques which were briefly reviewed are: (1) linear programming; (2) non-linear programming; (3) dynamic programming; and (4) simulation. Three projects of aquifer operation and management in which the above techniques were used were briefly described. These projects were located in Southern California, the Indus Valley, and Israel. In Israel and the Indus Valley quality consideration weighed heavily in the derivation of design criteria or operation rules. (Has 33 references.)
W68-00377

AN ANALYSIS OF RESERVOIR CAPACITY REQUIREMENTS FOR CONJUNCTIVE USE OF SURFACE AND GROUNDWATER STORAGE,
Calif. Univ., Los Angeles.
Nathan Buras, and Warren A. Hall.
Int Ass of Sci Hydrol, Publication No 57, Vol 2, pp 556-563, Sept 1961. 7 p, 1 tab, 18 ref.

Descriptors: *Conjunctive use, Surface water, Groundwater, *Dynamic programming, Optimization, Benefits, Discount rate, Flood water, Hydroelectric power, *Mathematical model, Demand.
Identifiers: Recurrence relationships, Policy.

Discrete dynamic programming was used to determine surface storage capacity of a reservoir, which was used in conjunction with a groundwater reservoir. The objective was to maximize total present value of net benefits over a reasonable economic life of the system. The problem resulted in a three-dimensional matrix. The policy was obtained by first considering the operational problem, and then establishing the water allocation to the two reservoirs. In solving the problem, water demand and inflows were assumed known. The allocation was shown to be an 'all or nothing' decision depending on the state of the system. (Has 18 references.)
W68-00378

OPTIMUM DESIGN OF A MULTIPLE-PURPOSE RESERVOIR,
Calif. Univ., Los Angeles.
Warren A. Hall.
Amer Soc Civil Eng Proc, Vol 90, No HY4, pp 141-149, July 1964. 8 p, 2 fig, 6 ref.

Descriptors: *Multiple purpose reservoirs, *Dynamic programming, Cost-benefit ratio, Marginal benefits, Flood control, Operations research, Water users, Optimization, Low flow augmentation, Municipal water, Industrial water, Irrigation, Fixed costs, Marginal costs, Reservoir design, Reservoir operation, Regulated flow.
Identifiers: Optimum policy, Hydroelectric releases.

Dynamic programming was used for the design of a multiple-purpose water project. By assuming that various users are independent and by allocating them larger regulated flows, a hypothetical but related problem was obtained. It was then shown that by solving the hypothetical problem a solution to the actual problem was also obtained. The only difference between the two solutions being a reduction in the expected fixed costs in the optimal solution to the actual problem. An analysis of benefits derived from flood control measures was included.
W68-00380

OPERATING A LIMESTONE AQUIFER AS A RESERVOIR FOR A WATER SUPPLY SYSTEM,
Tahal, Water Planning for Israel, Tel Aviv.
Y. Harpaz, and J. Schwarz.
Bull of the Inter Ass of Sci Hydrol, Vol XII, No 1, pp 78-90, March 1967. 13 p, 9 fig, 8 ref.

Descriptors: *Aquifer, *Reservoir operation, Water supply, Groundwater recharge, Optimization, Limestones, Hydrologic properties, Mathematical model, Water demand, Benefits, Pumping, Pumping plants.
Identifiers: Electric analog, Israel, Present value.

Dynamic programming was used to optimize the operation of a limestone aquifer. A detailed geologic, hydrologic and mathematical description of the aquifer was presented. A brief description of an electric analog of the same aquifer was also given. The objective was to maximize the expected present value of net benefits which were derived from water pumpage and recharge. Simplified actual demand curves were used. The planning horizon was 12 years, and the interest rate was 8 percent. Resulting policy was summarized as follows: (1) at high water tables pumping should be carried to full installed capacity, supplying local and regional needs; (2) at lower water tables supply only local needs; (3) recharge becomes feasible at low water tables; (4) operating policies differed from winter to summer; and (5) by comparing the present value to costs of installation, the optimal size of additional installation may be determined.
W68-00388

OPTIMAL CONTROL OF LINKED RESERVOIRS,
Water Res Ass, Medmenham, Buckinghamshire, England.
Z. Schweig, and J. A. Cole.
Water Resources Res, Amer Geophys Union, Vol 4, No 3, pp 479-497, June 1968. 18 p, 3 fig, 5 tab, 13 ref.

Descriptors: *Optimization, *Dynamic programming, *Reservoir operation, Reservoir storage, Stochastic processes, Long-term planning, Correlation analysis, Digital computers, Conjunctive use, Water resources, Aquifer, Operating costs.
Identifiers: North Wales, Lake Vyrnwy.

Discrete stochastic dynamic programming was effectively used to find rules for optimal operation of two linked reservoirs having a common draft demand. Releases could be made from either one, but transfers were allowed only from the smaller to the large reservoir. The system parameters were probabilistic inflows, aquifer draw-off, storage volumes, and operating costs. Both cross and serial correlation of inflows were considered. The objective was to minimize the long run transmission, purification, storage, and other variable costs. An hypothetical example was presented and solved. A flow diagram for a digital computer program was also presented along with a computer solution to a problem based on actual statistics for Lake Vyrnwy, North Wales, and an hypothetical aquifer. For this semi-hypothetical example the steady state solutions were obtained after 32 to 42 monthly stages. The long term operating costs can be derived from these steady states. These costs could be considered at the design stage of the system.
W68-00389

A MODEL STATE WATER CODE FOR RIVER BASIN DEVELOPMENT,
Frank J. Trelease.
Law and Contem Prob, Vol 22, No 2, p 301-322, Spring 1957. 22 p, 122 ref.

Descriptors: *River basin development, Resource allocation, Federal-state water rights conflict, Riparian land, Riparian water, *Riparian rights, Appropriation, Natural flow doctrine, *Prior approprition, Eminent domain, Social needs, *Priorities, Reasonable use, Land tenure, Interstate compacts, State jurisdiction.

Although particular water development problems differ, some criteria may be defined that will have universal validity. The basic assumption is that all water allocation problems have one feature in common, which is that there is not enough water for all possible uses, and some choice must be made among competing users. The first prerequisite of a model state system of water law is that it should encourage, or at least not deter maximum development. It must provide secruity to the water user for his investment in facilities and yet be sufficiently flexible to permit change in the existing patterns of resource use. It should also protect the public interest by obtaining the optimum development possible while providing for navigation, fishing and recreation. The author compares the existing legal theories applicable to water allocation and concludes the prior appropriation is the best extant system of law for river basin development in the United States.
W68-00448

THE MOVEMENT FOR NEW WATER RIGHTS LAWS IN THE TENNESSEE VALLEY STATES,
Tennessee Univ., Knoxville.
Robert H. Marquis, Richard M. Freeman, and Milton S. Heath.
Tenn L Rev, Vol 23, No 7, pp 797-837, Apr 1955. 41 p, 202 ref.

Descriptors: Beneficial use, Consumptive use, Reasonable use, Water consumption, Water shortage, *Water allocation (Policy), Evaluation, Governments, State governments, *Tennessee River, Water law, *Water policy, Eminent domain, Legal aspects, Legislation, Prior appropriation, Riparian rights, Water permits.
Identifiers: Constitutional law, *Tennessee Valley.

A discussion of the existing water rights law in the Tennessee Valley states and the need for a change in view of expanding use of water and possible shortages is presented. Three years of abnormally low rainfall brought the problem to the attention of the state legislatures. Prior appropriation has been advanced as an alternative to the riparian doctrine on the idea that water not used by riparain owners may be unusable by anyone. All of the Tennessee Valley states had adopted the riparian doctrine. It is concluded that prior appropriation has not been uniformly interpreted, and without some modification would not provide an adequate solution. The constitutional question presented by legislation destroying unused riparian rights without compensation is given attention. Possible alternatives offered include: (1) extension of the reasonable use doctrine, (2) extension of the power of eminent domain, (3) permits for water use, (4) the California system, and (5) modified prior appropriation. The improbability of achieving a completely satisfactory solution is noted, but the need for study is emphasized.
W68-00452

THE OPTIMUM USE OF A GROUNDWATER AND SURFACE-WATER SYSTEM: A PARAMETRIC LINEAR PROGRAMMING APPROACH,
California Univ., Water Resources Center, Berkeley, Calif.
John A. Dracup.
Univ of Calif Water Resources Center Contrib No 107, 134 p, July 1966. 17 fig, 23 tab, 55 ref.

Descriptors: *Programs, *Decision making, Surface-groundwater relationships, *Mathematical models, Computer programs, California, Artificial recharge, Economics, Water demand, Water reuse, Legal aspects, Systems analysis, Water utilization, *Planning.
Identifiers: *Parametric linear programming, *San Gabriel Valley, Problem solving, Engineering aspects, Water import, Water needs.

A mathematical model for a surface and groundwater system is formulated to represent the San Gabriel Valley in southern California. This model is then used to solve the algorithm of parametric linear programming. Unit cost of water importation, treatment, storage, pumpage, boostage, and artificial recharge to aquifers is determined by economic analysis. 5 sources of water are utilized to optimally satisfy 3 water requirements. The sources of supply are local surface water, imported Feather River water, imported Colorado River water, groundwater pumpage, and reclaimed waste water. The analysis is for 1960-90 and covers water requirements for municipal and industrial demands, agricultural needs, and artificial recharge of the groundwater aquifers. 3 decision rules, which may be implemented by a planning agent, are analyzed to determine optimum operating procedure. A sensitivity analysis on the cost coefficients and the significance of the shadow or imputed prices are included. The method is effective as a guide for long-range optimum decision-making for water-resources systems.
W68-00549

THE BIG WATER FIGHT.
League of Women Voters of the United States.

Stephen Greene Press, Battleboro, Vermont, 246 p, 1966. 3 fig, 2 map, 21 photo, 2 tab, 86 ref, 3 append.

Descriptors: *Water resources, Planning, *Political aspects, Water conservation, *Water management (Applied), *Water policy, Water pollution, Water quality, *Water resources development, Legislation, Water Resources Planning Act, Federal Government, Flood plain zoning, Governments.
Identifiers: League of Women Voters, Citizen interest and political action, Area development.

The League of Women Voters considers planning to be essential in providing enough water for future needs, reducing water pollution, preserving natural values, and providing public recreational facilities. Therefore, the League compiled its experience in the study of water problems and in helping public planning agencies. The volume explains why the League is interested in water problems in its preface. Chapter 1 describes League activity in obtaining water supplies in several communities and states. Chapter 2 concerns citizen, State, and Federal action in pollution reduction and control. Chapter 3 is on flood control planning. Chapter 4 explains comprehensive water resource planning on municipal, State, and Federal levels. Chapter 5 is about basin planning and how local leagues act together to promote it. Chapter 6 amplifies chapter 5 with a specific example, the SuAsCo basin in Massachusetts, of how 14 leagues cooperated. Chapter 7 is a further expansion of chapters 5 and 6. Chapters 8 and 9 explain how citizen action may best be applied to obtain desired results from government agencies on all levels. The 3 appendices list agencies in the water resources field, a glossary of terms used, and suggested reading.
W68-00550

THE SENATE SELECT COMMITTEE ON NATIONAL WATER RESOURCES: AN ETHICAL AND RATIONAL CRITICISM,
U of New Mexico School of Law, Albuquerque.
Roy Hamilton.
Natural Resources J, Vol 2, No 1, pp 45-54, April 1962. 10 p, 34 ref.

Descriptors: *Federal government, *Institutional constraints, *Water resources development, Water policy, *Political aspects, Political constraints.
Identifiers: *Senate Committee on Water Resources.

The final report of the Senate Select Committee on National Water Resources stated that water development projects would be needed by 1980 at a projected cost of more than 50 billion dollars. The author considers how the Committee arrived at its conclusions and whether the conclusions reached could have been predicted at the outset, after the makeup of the Committee was known. The operations and background of the Committee are described. The essential point of the article is that because the Committee was composed almost exclusively of Western Senators, their findings and recommendations were western oriented, while eastern interests were slighted. The Senate is sharply criticized for utilizing a committee as an interest group. The Senate, according to its traditional responsibility of being a mediator, should have balanced the composition of the Committee with eastern Senators.
W68-00614

INCOME DISTRIBUTION AND PLANNING FOR PUBLIC INVESTMENT,
Bowdoin College, Brunswick, Maine.
A. Myrick Freeman, III.
American Econ Rev, Vol LVII, No 3, pp 495-508, June, 1967. 14 p, 2 fig, 6 ref.

Descriptors: Constraints, National income, *Cost-benefit analysis, Taxes, Marginal costs, Marginal productivity, *Repayment contracts, *Project planning, Variable costs, Transfer.
Identifiers: *Social welfare function, *Income distribution, *Project design, Subsidy, Maximization, Optimum scale.

This paper considers the implications for public investment criteria of introducing income redistribution as a policy goal since this seems to be a major reason for undertaking many programs. The limitations of cost-benefit analysis in this area can only be overcome by invoking some sort of value judgment by which alternative distributions of income can be judged. It is assumed that a social welfare function exists which weights increments of income to individuals on the basis of a downward sloping constant elasticity of marginal social welfare schedule, whose parameters are known. When the incidence of benefits and costs is known, welfare weighted benefit-cost ratios can be calculated,

these will differ from conventional ratios. When projects are designed to maximize social welfare we focus on two variables, project scale and the degree of repayment by the beneficiaries of the project. If repayment is fixed, and if the project redistributes income on the average toward lower persons, the welfare maximizing project will be larger than the efficiency maximizing project. If there is no repayment constraint project scales are the same and the welfare criterion determines the optimum repayment policy.
W68-00643

A GENERALIZED APPROACH TO ESTIMATING RECREATION BENEFITS,
Rutgers State University, New Brunswick, New Jersey.
Joseph J. Seneca.
Unpub Ph D dissert, Univ of Pennsylvania, 1968. 210 p, 14 fig, 13 tab, 51 ref, 3 append.

Descriptors: *Recreation demand, *Tennessee Valley Authority, *Elasticity of supply, *Estimating equations, *Delaware River, Natural resources, Least squares method, Welfare, Fringe benefits, Cost-benefit analysis, Geographical regions.
Identifiers: *External economies, *Public good, *Public policy, *Pareto optimum, *Market failure, *Identification problem, Reduced form.

Many public investments could be further justified by the potential recreation benefits which they contain. The problem is to determine a methodology to measure the magnitude of these benefits. The method introduced is to estimate both demand and supply input elasticities through the pooling of cross-section and time series data. Optimal input mix is determined from an estimated reduced form equation derived from a model of the recreation market. Cross-section demand equations are estimated for a variety of water oriented outdoor recreation activities for the four regions of the country. A pooling of historical data and cross-section elasticities enables the refinement of the supply elasticities of the reduced form. Empirical examples of the reduced form estimation and pooling technique are provided along with the use of the cross-section demand functions for the determination of recreation benefits resulting from improved water quality conditions in the Delaware Estuary in a marginal benefit-cost analysis.
W68-00645

ECONOMICS OF PRODUCTION FROM NATURAL RESOURCES,
Brown University, Providence, Rhode Island.
Vernon L. Smith.
American Econ Rev, Vol LVIII, No 3, part 1, pp 409-431, June, 1968. 23 p, 8 fig, 14 ref, 1 append.

Descriptors: Balance of nature, Environmental effects, Capital, *Natural resources, Profit, Equilibrium, Operating costs, Technology, *Commercial fishing, *Lumbering, *Mineral industry, *Oil industry.
Identifiers: Externalities, *Extractive industry, *Common property resources, *Replenishable resources, Recovery cost, Social cost.

A single industry model is developed to describe a dynamic recovery process from such technologically diverse resources as fish, timber, petroleum and minerals. Commercial fishing represents the general model because the resource is replenishable and exhibits important production externalities. Petroleum recovery exhibits resource stock externalities, but growth is identically zero. Timber is a replenishable resource, but stock externalities are not significant. Finally, mining is treated as a non-replenishable resource with no production externalities. The externalities treated in fishing and petroleum theory arise because of the common property character of the resource. It is demonstrated that if the resource can be appropriated, or exclusive access rights granted, the external costs become 'privatized', and decentralized competitive exploitation is efficient. The regulatory problem is one of inducing competitive industry to take account of social costs. A partial equilibrium solution is provided whereby it is shown that an annual license fee together with a unit extraction fee will reflect the appropriate crowding and stock externality costs to the competitive producer.
W68-00646

PERFORMANCE CRITERIA FOR EVALUATING ECONOMIC DEVELOPMENT POTENTIAL: AN OPERATIONAL APPROACH,
Northwestern University, Evanston, Ill and The American University, Washington, DC.
Irma Adelman, and Cynthia Taft Morris.
Quart Jour Econ, Vol LXXXII, No 2, pp 260-280, May 1968. 21 p, 5 tab.

Descriptors: *Classification, Gross national product, Leadership, Crop production, *Growth rates.
Identifiers: Social overhead capital, Financial institutions, *Development potential, *Discriminant functions, Analysis of variance.

The aim is to devise relatively objective criteria for identifying underdeveloped countries with good development potential. 73 non-communist underdeveloped countries were classified into 3 groups on the basis of their average annual rate of growth of real per capita GNP from 1950-51 to 1963-64 and other measures of economic performance. Stepwise analysis was used to determine those linear combinations of performance characteristics which best discriminate among various groups of countries. In selecting variables for this function the analysis at each step scans the entire list of variables not already in the discriminant function and then selects that variable which adds most to the explanation of variance between group means. In this case the analysis was performed with 29 variables representing a wide range of social, political and economic characteristics. From these the method picked out four traits most relevant to potential for successful economic performance. These four in order of statistical importance were: (1) Degree of improvement in financial institutions; (2) Degree of modernization of outlook; (3) Extent of leadership commitment to economic development; and (4) Degree of improvement in agricultural productivity.
W68-00648

A PROPOSED NORMALISATION PROCEDURE FOR PUBLIC INVESTMENT CRITERIA,
London School of Economics, Great Britain.
E. J. Mishan.
Econ Jour, Vol LXXVII, No 308, pp 777-796, Dec, 1967. 20 p, 2 tab, 23 ref, append.

Descriptors: Return, *Interest rate, *Discount rate, Investment, Project planning.
Identifiers: *Present discounted values, *Internal rate of return, Terminal value.

Over time the development of criteria for public investments has favored the admitting and ranking of public projects by comparing the present discounted values of their streams of returns rather than comparisons based on the internal rate of return. This paper attempts to make explicit a normalisation procedure setting forth the conditions under which comparisons of investment streams by either criterion have equal economic significance. The resulting normalised investment criteria, whether based on internal rate of return or on present discounted value, invariably produce the same ranking for any given set of investment projects. One implication of this procedure, notwithstanding that future negative returns of an investment stream may produce more than one positive internal rate of return ordinarily defined, is that the economics of the normalisation procedure entails a definition more apt to the concept of an internal rate and one yielding a unique value.
W68-00649

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

COST ALLOCATIONS, COST SHARING, PRICING AND REPAYMENT,
International Joint Commission, US Section, Washington, DC.
Eugene W. Weber.
Water Resources Bull, Vol 4, No 1, pp 37-45, Mar 1968. 9 p.

Descriptors: *Cost allocation, Reimbursable costs, *Cost repayment, *Cost sharing, Multiple-purpose projects, Cost-benefit analysis, Water quality control, Flood control, Recreation, Transportation, Sediment control, Hydroelectric power, Social values, Legislation, Decision making, Water management (Applied), Coordination, *Pricing.
Identifiers: *Beneficiaries, Equitable budgeting, Case studies, Problem solving, Navigation, Irrigation.

This paper reviews the effects of cost allocation and cost sharing practices upon various society objectives; it identifies needs for research leading to improvement of these phases of water management. Although sound in principle, cost allocation procedures are subject to questions in application to purpose, benefits, discount rates, and alternatives which are factors in the allocation process. Cost sharing practices may vary widely in the extent to which costs are borne by beneficiaries. Reasons for and effects of these variations are needed to evaluate the practices. Certain cost sharing policies, in flood control and water quality control for example, are not conducent to decisions that will result in wise use and equitable costs from the standpoint of society. Policies related to navigation and irrigation raise questions as to their effect on choice of alternative ways of accomplishing various objectives. Case studies are a practicable approach to understanding the factors involved. These studies can guide in the correction of obvious inadequacies and contribute to more equitable water management.
W68-00343

AN UNIVARIATE ALLOCATION ALGORITHM FOR USE IN FORESTRY PROBLEMS,
Auburn Univ, Auburn, Ala.
James N. Hool.
J Forestry, Vol 66, No 6, pp 492-493, June 1968. 2 p, 3 tab.

Descriptors: Administrative decisions, *Comparative benefits, Computer models, Digital computers, *Dynamic programming, Economic efficiency, Estimated benefits, Future planning (Projected), Numerical analysis, Operations research, Optimization, *Optimum development plans.
Identifiers: Univariate allocation algorithm, Allocation problems.

A discrete dynamic programming algorithm was presented for the optimization of a univariate allocation problem. A hypothetical example of the number of a maximum possible days to be allocated to the sale of Christmas trees in any of three markets illustrated the computational efficiency of the algorithm. Calculations were presented in tabular form showing the progressive elimination of all non-optimal solutions and demonstrating the applicational appeal of large problems of this type to computer programming.
W68-00371

UNITED STATES V RANDS (VALUE OF CONDEMNED LAND BASED ON USE AS A NAVIGABLE PORT SITE).

88 S Ct 265 (1967).

Descriptors: *Condemnation value, Compensation, Land appraisal, Condemnation, Federal jurisdic-

ion, High water mark, Value, Eminent domain, Water utilization, Navigable waters, Water law, *Riparian rights, Riparian land.

The question presented is whether the compensation which the United States is constitutionally required to pay when it condemns riparian land includes the value of the land as a port site. The Court held that the Fifth Amendment does not require that the compensation include the value of and arising from the fact of riparian location. The trial court in the condemnation action held that the compensable value of the land taken was limited to its value for sand, gravel, and agricultural purposes and that its special value as a port site could not be considered. The Supreme Court agreed in holding that the value derived from the fact of riparian location depends on the use of the water to which the company has no right as against the United States. Rights of access to navigable waters and values given a riparian owner by state law, are good against other riparian owners but are not assertable against the superior rights of the United States, are not 'property' within the Fifth Amendment, and need not be paid for when appropriated by the United States.
W68-00411

PRELIMINARY INVESTIGATION OF THE WATER RESOURCES OF ISABELLA COUNTY, MICHIGAN, AS REPRESENTED BY FARM PONDS,
Central Michigan University.
Wakelin McNeel.
Annual Progress Report on Project to Office of Water Resources Research, August 1968. 1 p.

Descriptors: *Farm ponds, Pondage, Construction costs, *Cost-benefit analysis, Maintenance costs, Fish populations.

Three farm ponds each with different bottom types were examined as to certain chemical and physical properties, rate of fish growth, and total fish mass. Data is presented on these findings. Approximately 90 farm pond owners were interviewed to determine costs of construction, improvements, and maintenance of their ponds. Information as to fish plantings, kinds of useage, man hours of various recreational uses, and benefits derived from the ponds including income was obtained.
W68-00494

AN ANALYSIS OF ALTERNATIVE METHODS OF FINANCING TYPES OF WATER RESOURCE FACILITIES IN MISSISSIPPI,
Bur. of Bus. and Economic Research, Miss. State Univ., State College, Miss.
G. T. Peden, Jr., J. R. Pulley, and J. L. Roberts, Jr.

Completion Report to the Office of Water Resources Research, Department of the Interior, June, 1968, 100 p.

Descriptors: *Finance, Water facilities, Loans, Mississippi, Small communities.

The primary purpose of the study was to determine and analyze the alternative methods used by rural communities and small incorporated municipalities in a fourteen-county area in Central Mississippi for the period beginning July 1, 1962, and ending June 30, 1967. Special attention in the analysis was given to the method of financing used, the type of facilities it was used to finance, and any problem areas that arose in either attaining the funds or administering the chosen method. The findings from this study and analysis were divided into two distinct sections. One section pertains to rural water associations as defined by the Farmers Home Administration of the U. S. Department of Agriculture. The other section dwelt on the conclusions regarding incorporated municipalities which were either unable or chose not to utilize the credit facilities of the Farmer's Home Administration.
W68-00504

FEASIBILITY OF WATER EXPORT,
Manitoba Univ., Winnipeg, Canada.
Edward Kuiper.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6024, pp 873-891, July 1968. 19 p, 5 fig, 1 tab, 6 ref, 2 append.

Descriptors: *Water supply, *Cost analysis, Water resources development, *Water management (Applied), *Irrigation, Waste dilution, United States, Water policy, International law, Economic impact, River systems, Diversion, Multiple-purposes projects, Water utilization, Dams, Pumping plants, Canals.
Identifiers: *Water export, *Canada, Political feasibility, Water surplus, Export-import treaty, Canadian water needs.

A review is made of the various problems associated with exporting water from one country to another. The criteria that must be satisfied prior to export, and their application to the Canada-United States situation, are described. The continent is divided into 3 regions: mountain west, prairie, and east. Calculations are made of the amount of present and foreseeable Canadian water surpluses and the price of export in each of the regions. In the mountain west at least 100,000,000 acre-ft per yr in British Columbia and the Yukon and a similar amount in the prairie and Northwest Territories are available; in the east at least 200,000,000 acre-ft per yr are available in northwest Ontario. The price of export to the U S from British Columbia may be $20-$30 per acre-ft, and from Ontario into the Great Lakes, $10-$15. Water from the Prairie Province could cost $25 per acre-ft. In addition, conveyance costs in the United States would be expensive. Such costs appear too high for development projects under present economic circumstances. No major obstacle is apparent to making an export-import treaty, provided Canadians are enlightened of the favorable impact on the economics and well-being of both countries by joint water developments.
W68-00537

INVESTMENT-DECISION CRITERIA, INVESTMENT INCENTIVES AND THE CHOICE OF TECHNIQUE,
Trinity Hall, Cambridge, Great Britain, and the University of Adelaide, Australia.
G. C. Harcourt.
Econ Jour, Vol LXXVIII, No 309, pp 77-95, March 1968. 19 p, 5 fig, append.

Descriptors: Technology, Depreciation, *Investment, *Grants, *Taxes, Income, Profit.
Identifiers: Present value rule, Pay-off period criterion, *Capital intensive techniques, Corporation taxation, *Fiscal incentives.

This article analyzes the relative capital-intensities which result from the use of three investment-decision rules- the present value rule, payoff period criterion, and accounting rate of profit rule- in a situation characterized by a common technology and given expectations, first in situations in which taxation and investment incentives are ignored, and, secondly, in which they are introduced, both in a simple way and as they have been in the United Kingdom. The main results are that in both situations, the pay-off period criteria often results in the choice of a more capital intensive technique than the other rules. Nothing general can be said about the other two rules. Taxation by itself results in less capital-intensive techniques being chosen by the first two rules but has no effect on the third. Investment incentives result in more deepening than otherwise would have occurred if the first two rules are used but can have a 'perverse' effect if the accounting rate of profit rule is used. If at the introduction of the corporation tax and cash investment grants in the U.K. a firm changed from the pay-off period to a Discounted Cash Flow procedure it might choose less capital intensive techniques.
W68-00644

PEAK LOAD PRICING,
National Board for Prices and Incomes, London, Great Britain.
Ralph Turvey.
Jour Pol Econ, Vol 76, No 1, pp 101-113, Jan/Feb 1968. 13 p, 19 ref.

Descriptors: Technology, Hydroelectric power, *Electric power demand, *Electric power rates, *Electric power costs, Operating costs, *Peaking capacities, Optimization, Measurement.
Identifiers: Area Board, Great Britain, *Marginal cost of capacity.

The main assumption of solutions to this pricing problem is that our aim is to maximize the sum of producers' and consumers' surpluses. The optimum requires price (p) to exceed marginal running cost (MRC) in periods of high demand by amounts which both restrict demand to capacity output and which sum up over these periods to equal the marginal cost of capacity; for other periods p=MRC. The first assumptions to be dropped are constant MRC and constant incremented capacity costs. As a result the p which is equal to an upward sloping MRC curve in off-peak periods is a variable one, requiring a complex tariff. For new additions, running costs are lower due to technological improvements, but changes in cost can only be estimated given assumptions about the future development of the load and of technology. Other assumptions considered unrealistic are: capacity is constant throughout all periods of the demand cycle; demand curves are independent for different periods in the cycle; demand curves are not stochastic. The present limit is 2, 3, or 4 rates plus alternatives such as restrictions on supply. Yet theoretical analysis has provided a criterion for comparing non-ideal tariffs.
W68-00650

CEGB'S BULK-SUPPLY TARIFF AND LONG-RUN MARGINAL COST,
Central Electricity Generating Board, Great Britain.
P. E. Walts.
Econ Jour, Vol LXXVIII, No 309, pp. 67-76, March, 1968. 10 p, 2 fig.

Descriptors: *Marginal costs, Investment, Long-term planning, *Electric power rates, Load distribution.
Identifiers: Basic capacity charge, Peaking capacity charge, Area boards, *Bulk Supply Tariff, *Incremental costs.

The Central Electricity Generating Board is introducing a tariff for bulk supplies with unit rates based on short run marginal costs, a peaking capacity charge related to the rate of take at system peak and a basic capacity charge related to the rate of take over the winter 'plateau'. A case for two capacity charges in a tariff intended to reflect long run marginal cost is stated. It is also shown how obsolescence influences the conversion of long run marginal costs, calculated as present values of system incremental costs, into annual tariffs.
W68-00651

6D. Water Demand

THE CONCEPT OF REASONABLE BENEFICIAL USE IN THE LAW OF SURFACE STREAMS,
Wyoming Univ., College of Law.
Frank J. Trelease.
Wyo L J, Vol 12, No 1, pp 1-21, Fall 1957. 22 p, 162 ref.

Descriptors: *Relative rights, *Competing uses, *Reasonable uses, Prior appropriation, Riparian rights, Riparian owners, Artificial use, Domestic water, Irrigation water, Stock water, Beneficial use, Water utilization, Preferences (Water rights).

This is an analysis of general and western law of water use by riparian owners. The riparian and

prior appropriation systems are compared. In the riparian system 'natural' uses (domestic stock watering) are generally preferred over 'artificial' uses (irrigation, manufacturing). An upper natural user may take all the water to the exclusion of a lower artificial user. In the prior appropriation system, water appropriated must be used for a useful and beneficial purpose, otherwise no valid appropriation has been made. Most litigation arises on the issue of comparative reasonableness of use. Legislatures have affected the beneficial use doctrine by the enactment of water use preference statutes. The author suggests that allocation of water should be left more to economists, engineers and administrators than strictly to the law.
W68-00403

BENEFICIAL USE OF WATER,
Neal H. Bell.
Willamette L J, Vol 3, No 4, pp 382-390, Fall 1965. 9 p, 45 ref, disc.

Descriptors: *Prior appropriation, *Beneficial use, Legislation, Administrative agencies, Reasonable use, Consumptive use, Water conservation, *Water allocation (Policy), Aesthetics.

Prior appropriation states have invariably included the guiding standard of 'beneficial use' in their water codes. This article is an analysis of that term. Under the appropriation doctrine 'beneficial' does not necessarily mean reasonable in relation to the rights or needs of others. However, the reasonableness of the contemplated use is usually taken into account by the administrative agency which regulates the use of water in the state. Beneficial use normally involves putting water to a useful purpose that will reap economic rather than aesthetic benefits. However, there is a trend toward recognizing aesthetic uses as beneficial particularly where the scenic attractions will be public. It is generally required that an appropriator have a possessory interest in the land on which the water is used. Several approaches are discussed which allow water distribution companies, which have no interest in the land, to appropriate water. Waste is usually assumed to be synonomous with nonbeneficial use. Reasonable losses by evaporation and leakage, however, are not considered nonbeneficial. Under some legislation no change in use or place of use can be made without application to the state administrative agency.
W68-00408

RIPARIAN RIGHTS--ANALYSIS OF NEW STATUTORY PROVISIONS,
Kentucky Univ., Lexington.
J. Arna Gregory, Jr.
Ky L J, Vol 43, No 3, pp 407-415, Spring 1955. 9 p, 33 ref.

Descriptors: *Kentucky, *Riparian rights, *Reasonable use, Natural flow doctrine, Surface runoff, Domestic water, Impounded waters, Legislation, Legal aspects.

The rights of landowners to use the water resources on and contiguous to their land have been substantially clarified by enactments of the 1954 Kentucky General Assembly. Prior to the enactment of this legislation neither the appellate courts of the state nor the legislature had decided whether the natural flow doctrine or the reasonable use doctrine governed riparian rights. The new legislation attempts to set out some applicable basic principles designed to establish the reasonable use doctrine in the state. The statute makes all natural bodies of water subject ot regulation except diffused surface water and water left standing in natural pools after streams have receded. The statute also provides that a riparian owner may use an unlimited amount of water for domestic purposes, but any use other than domestic must be reasonable use. A reasonable use is said to be one which will not deny to others enough water for domestic purposes or impair any existing use of others previously established. Finally, a riparian landowner is permitted to impound water when the flow or level of water is in excess of existing reasonable use.
W68-00409

TORTS--NUISANCE--INTERFERENCE WITH THE FLOW OF SURFACE WATER,
Thomas H. Burnett.
Ky L J, Vol 50, No 2, pp 254-257, Winter 1961-1962. 4 p, 22 ref.

Descriptors: *Surface runoff, Repulsion (Legal aspects), Civil law, Reasonable use, *Kentucky, Water law, *Surface drainage, *Judicial decisions.
Identifiers: *Civil law rule, *Reasonable use rule.

Hopson v. Downs, 340 S. W. 2d 475 (KY. 1960), a case involving backup of water from defendant's property onto the plaintiff's land during an unprecendented rainfall, allegedly caused by inadequacy of defendant's drain pipes, held, inter alia, that the civil law rule of absolute liability for obstruction of surface waters was applicable under the facts of the case. There are three principal theories of liability for interference with surface waters in the United States. These are the civil law rule, the common enemy rule and the reasonable use rule. The reasonable use rule is followed in three jurisdictions, and the remaining jurisdictions are about evenly divided between the civil law rule, the common enemy rule and the reasonable use rule. The reasonable use rule is followed in three jurisdictions, and the remaining jurisdictions are about evenly divided between the civil law and the common enemy rules. The article examines the benefits and deficiencies of each, and concludes that the reasonable use rule is the better of the three. The reasonable use rule allows a landowner to alter the flow of surface water so as to injure another landowner, provided he does so in order to make a reasonable use of his land.
W68-00415

ANNTCO CORP V SHREWSBURY BANK AND TRUST CO (DIVERSION OF RUNOFF FROM A SMALLER DRAINAGE SYSTEM IN A LARGER SYSTEM).

230 N E 2d 795. (Mass 1967).

Descriptors: *Massachusetts, *Easements, *Drains, *Drainage, Judicial decisions, Conduits, Legal aspects, Subsurface drains, Culverts, Pipes, Subsurface drainage, Drainage systems.
Identifiers: *Injunctions.

This is a bill in equity to enjoin a continuous trespass by defendant in draining water from his premises into a conduit running through plaintiff's land. Plaintiff bought this land subject to an easement in the Commonwealth, consisting of a 30 in. drain pipe from an adjoining highway running under and across plaintiff's land. This easement had been granted by plaintiff's predecessors in title 'for public convencience and for the proper construction and care of said highway.' Defendant, an adjoining landowner, experienced problems with excess ground water and was granted a permit by the Department of Public Works to enter the state highway drainage system. Defendant thereafter drained his excess ground water through an 8 in. pipe into the 30 in. drainpipe. The court held: (1) Defendant's use of the 30 in. drain was a private purpose not within the scope of the easement; (2) Defendant's action had lessened the value of plaintiff's property; (3) Defendant's action constituted an undue burden on plaintiff's property. Plaintiff was therefore entitled to injunctive relief.
W68-00425

CRAWFORD V CITY OF MERIDIAN (ALTERATION OF SURFACE RUNOFF QUANTITY BY LANDFILL AND CONSTRUCTION).

186 So 2d 250-253 (Miss 1966).

Descriptors: *Mississippi, *Surface runoff, *Obstruction to flow, Ditches, Diffused surface waters, Alteration of flow, Drains, *Drainage, Floods, Surface drainage, Relative rights, Drainage patterns, Water law, Judicial decisions.
Identifiers: Swale ditch, Natural drainage, Damage (Legal aspects).

This is an action against the City of Meridian and the owners of property adjacent to plaintiff for damage allegedly caused by the city's negligent blocking of a water drain and adjacent landowner's negligent filling of a swale water drain. A shallow swale ditch ran between plaintiff's lot and defendant's adjoining lot. Plaintiff's contend that the swale ditch gathered and conveyed surface water from plaintiff's land to another ditch which drained the water away. The city paved a street, blocking access to the second ditch, and the adjoining landowners filled in the swale ditch. It is claimed that these activities of defendants caused surface water to flood plaintiff's driveway. Defendants offered evidence that plaintiff's house was in a natural trough or depression. This court held that the jury had ample evidence on which to base a verdict for defendants. This case deals largely with a discussion of evidence and discretion of the trial court.
W68-00431

WATERS AND WATERCOURSES--SUBTERRANEAN PERCOLATING WATERS--ACTION TO ENJOIN USE WHICH IMPAIRS ADJOINING LANDOWNER'S.
Vanderbilt Univ. Press, Nashville, Tennessee.

Vand L Rev, Vol 11, No 3, pp 945-948, June 1958. 4 p, 19 ref.

Descriptors: *Riparian rights, *Percolating water, *Reasonable use, Groundwater, Wells, Arkansas.

An analysis of an Arkansas decision holding that the riparian reasonable use rule is also applicable to percolating waters. Whether or not any given use is reasonable depends on the circumstances of the particular case. In this case the court, noting that the plaintiffs' land had little value except for domestic purposes, held that it was unreasonable for defendants to use thousands of gallons of water each day for processing chickens if such use deprived plaintiffs of sufficient water for domestic needs. Since the rule applied by the court takes into consideration the resulting effect upon landowners who draw from a common source of supply, it would seem that the result reached is very similar to that which would be reached by application of the correlative rights rule.
W68-00449

THE ORIGIN, GROWTH AND FUNCTION OF THE LAW OF WATER USE,
Univ. of Wyoming College of Law, Wyoming State Bar, Laramie, Wyoming.
William J. Burke.
Wyo L Rev, Vol 10, No 2, pp 95-111, Winter 1956. 17 p, 8 ref.

Descriptors: Preferences, *Riparian rights, *Prior appropriation, *Federal-State water rights conflicts, Navigable waters, Riparian waters, Social change, *Social function, Social needs, State governments.
Identifiers: Boulder Canyon Act.

A dichotomy of water law has evolved as the eastern and western states developed different principles concerning water use. The eastern states adhere to a modified riparian theory. However, they tend to consider water a vendible product and accomplish this end through government acquisition of lands contiguous to watercourses and by making riparian rights in the water subject to eminent domain. The western states apply the theory of prior appropriation. While a trend toward regarding water as vendible has not developed to the degree that it has in the eastern states. There are certain instances in which water is vendible. The

Federal Government initiated the practice of treating water project produced services, such as hydroelectricity, as vendible even where the water has not been so regarded. In some cases water in excess of the needs of the particular project has been treated as vendible. The failure of western states to develop water vendibility has created conflict with water allocation under federal projects with the effect that water rights under federal programs are granted by federal not state law.
W68-00450

A POTOMAC REPORT FOR THE CALANDER YEAR 1967.
Interstate Commission on the Potomac River Basin, Washington, DC.

Descriptors: *Water pollution control, *Water Quality Act, *River basin development, *Planning, Administration, Economic justification, Virginia, Maryland, District of Columbia, Pennsylvania, Runoff, Farm wastes, Sediment load, Industrial wastes, Municipal wastes.
Identifiers: *Potomac River Basin, Runoff waste control, Interstate Commission on the Potomac River Basin.

Progress of the Interstate Commission on the Potomac River Basin in complying with legal requirements for water quality and in setting its own new standards is described. Maryland's standards for the Potomac had FWPCA approval by the end of 1967, and the District of Columbia standards were approved in Apr 1968. Studies were made of runoff, sediment loads, farm waste contributions, and industrial waste abatement. The dimensions, population, ownership, land use, water resource development, water use, and waste discharges are summarized. The causes of pollution, its effects, and means of abatement are discussed. The status of governmental action on pollution abatement and compliance with Federal requirements for standards is given for each state in the Potomac Basin and for the District of Columbia. The work of other agencies in 1968 is briefly reviewed.
W68-00517

LEGAL PROBLEMS ARISING FROM THE CHANGING NEEDS, USES, AND AVAILABILITY OF WATER IN EASTERN UNITED STATES,
Thorndike Saville.
In Water Resources and the Law, pp 25-31, 1958. Michigan Univ. Law School, Ann Arbor, 7 p, 4 ref (see W68-00581).

Descriptors: *Water law, *Water resources, Beneficial use, Competing uses, Water conservation.
Identifiers: *Eastern U. S.

Beneficial uses and hazards of water are listed, demonstrating that insufficiency of water will cause some uses to conflict and that the useful supply may be increased by the amelioration or prevention of some of the hazards. Pressing water requirements in the East will cause a rationing of water under state administration. The causes of legal and administrative difficulties arising out of some of the conflicting or competing uses of water are considered. The four major factors causing water problems in the eastern United States are: (1) increase in population; (2) increased demand for electric power; (3) phenomenal amounts of water required by the newer chemical processes; and (4) increasing use of crop irrigation. One of the serious failures of many states in dealing with legal and administrative problems arising from extrastate authorities is the lack of a single state agency except in water pollution) sufficiently staffed to review federal programs and to deal effectively with federal agencies.
W68-00583

WATER USE UNDER COMMON LAW DOCTRINES,
Wilbert L. Ziegler.
In Water Resources and the Law, pp 51-86, 1968. Michigan Univ. Law School, Ann Arbor, 36 p, 145 ref (see W68-00581).

Descriptors: Watercourses (Legal), Surface runoff, Groundwater, *Water law, Percolating water, Underground streams, Watersheds (Basins), Remedies, Reasonable use, Judicial decisions, *Riparian land, *Riparian rights, Riparian waters, *Water rights, Water transfer, Water policy, Ownership of beds, Usufructuary right, Natural flow doctrine, Lakes.
Identifiers: Rule of correlative rights, Water waste, *Common-law doctrines.

Existing legal principles concerning water use and water rights are set forth, analyzed and summarized in order to establish a basis for remedial legislation. The law recognized three classes of water: (1) lakes and watercourses; (2) groundwater; and (3) diffused surface water. Lakes and watercourses are discussed regarding the problem of what constitutes riparian land and rules providing for quantity of water use. Attention is given to definition of terms, ownership of beds, extent of riparian land, problems within the watershed, use of water on riparian and non-riparian land, and limitation of remedies. There are two legal classifications for groundwater: subterranean watercourses and percolating waters. The same law applies to underground streams and surface watercourses. Three different rules regulate percolating water use: (1) the English rule; (2) the American or reasonable use rule; and (3) the rule of correlative rights. Each of these rules is discussed as it relates to waste and malicious interference with supply, use on land where the source is located, and use which interferes with surface flow. Diffused surface water is defined and rules governing its use are examined.
W68-00585

STATUTORY REGULATION OF WATER RESOURCES,
Wilbert L. Ziegler.
In Water Resources and the Law, pp 89-129, 1958. Michigan Univ. Law School, Ann Arbor, 41 p, 182 ref (see W68-00581).

Descriptors: Florida, Maryland, Mississippi, Minnesota, Iowa, Prior appropriation, *Legislation, Riparian land, Riparian rights, *Water law, *Water permits, *Water rights, Water allocation (Policy), Water policy, Consumptive use, Groundwater, Surface waters, Preferences (Water rights), Watercourses (Legal).
Identifiers: Permit system, Administrative procedure.

Water use statutes affecting ground waters and contained surface waters, characterized generally as appropriation legislation, are set forth and analyzed. Western prior appropriation statutes are treated briefly, followed by an examination of statutes governing only surface water or surface and ground water together enacted in states following the common law riparian doctrine. Water use legislation of a detailed nature has appeared as of 1958 only in five of the thirty-one riparian law jurisdictions. The statutes of Maryland, Minnesota, Mississippi and Iowa are similar, each having provisions for an agency to administer a permit system. These and other provisions are critically examined and compared. The Florida legislation is noted for a broad delegation of authority to administrative agencies, which includes the power to establish water conservation districts. Limited control of water in other jurisdictions is analyzed. Comprehensive legislation dealing with ground water problems is limited to western states. Groundwater legislation in the eastern states is usually of a stopgap nature, due to a relative abundance of water, concentrating on problems peculiar to the individual state. However, some legislation is partially affirmative rather than prohibitory.
W68-00586

THE RIPARIAN RIGHT AS PROPERTY--INTRODUCTION: LEGISLATIVE MODIFICATION OF THE RIPARIAN DOCTRINE,
Theodore E. Lauer.
In Water Resources and the Law, pp 133-137, 1958. Michigan Univ. Law School, Ann Arbor, 5 p, 10 ref (see W68-00581).

Descriptors: *Riparian rights, Riparian land, Riparian waters, *Legislation, Judicial decisions, Legal aspects.
Identifiers: *Constitutional law, *Property rights, Private property, Eastern U. S.

Solutions to the problems of water use and supply are often framed in terms of legislative modification of the riparian doctrine. This doctrine furnishes the exclusive legal basis for the use of the waters of streams and lakes in the eastern states. While adequate for the 19th century, this doctrine is unsuitable for the present century, due to the great increase of population and industry. Consideration of any proposal to modify the riparian doctrine must give weight to two factors: (1) the wisdom of the proposed legislation; and (2) the constitutional validity of the proposed legislative changes. Although legislative enactments modifying or limiting private property in the public benefit have been set aside with dismaying frequency as depriving persons of property without due process of law, it is the thesis of this chapter that the riparian right to use water, although 'property' in the legal sense of the word, in not absolute; by its very nature it is subject to substantial limitations. This chapter sets forth the scope of these limitations in order to comprehend more fully the legislative and judicial power to regulate or modify the riparian doctrine.
W68-00587

RIPARIAN RIGHT AS PROPERTY--THE ABSOLUTE RIGHT OF PROPERTY,
Theodore E. Lauer.
In Water Resources and the Law, pp 149-166, 1958. Michigan Univ. Law School, Ann Arbor, 18 p, 43 ref (see W68-00581).

Descriptors: Judicial decisions, Legal aspects, Ownership of beds, Public rights, *Riparian rights, Social aspects, *Usufructuary right, Water law, *Watercourses (Legal).
Identifiers: Private property, *Property rights.

Property under the law, as distinguished from property in a philosophical context, is not an absolute right, and is subject to substantial limitations. From the earliest times American jurists have recognized that particular rights of private property are the creation of law. What we call property is nothing more than the outline of certain rules of law governing the relationships between persons with respect to impersonal things. Things themselves are not property in the legal sense; they are merely the objects of property. The only broad limits on the rights of private property are practicability and the common good. These limitations are examined in detail. Corporeal objects which are governed by the law of property-especially unique objects, such as the sea, air, watercourses and flowing water-are analyzed. Among other conclusions, the article finds that there is no private property in the substance of flowing water; the most a person can have in this regard is a usufructuary right-a right to use the water.
W68-00589

THE RIPARIAN RIGHT AS PROPERTY--A LEGAL ANALYSIS OF THE RIPARIAN RIGHT TO USE WATER,
Theodore E. Lauer.
In Water Resources and the Law, pp 166-211, 1958. Michigan Univ. Law School, Ann Arbor, 46 p, 139 ref (see W68-00581).

Descriptors: Reasonable use, *Judicial decisions, Legal aspects, Legislation, Natural flow doctrine, Ownership of beds, Public rights, Riparian land, Riparian waters, *Riparian rights, *Usufructuary right, Water law, Watercourses (Legal).

Identifiers: Constitutional law, *Private property, *Property rights, Historical development.

This section of the article examines the riparian right in light of judicial and textual statements concerning its nature and extent. The riparian right, considered as an entity, is 'property.' But what is commonly designated as the 'riparian right' is but a complex legal structure composed of a number of individual rights, not all of which are entitled to constitutional protection. In order to ascertain the exact nature of these rights, both judicial statements as to the property nature of the riparian right and the historical development of the riparian right are analyzed. The historical development is examined as to the physical and legal basis of the riparian right and as to the usage of the riparian doctrine as a means of adjusting between the equal rights of riparian owners. After lenghty discussion it is concluded, inter alia, that although the simple right to the use of water may be a property right, there remains a substantial problem of whether the elaborate legal doctrine which the courts have formulated to govern the enjoyment of the usufructuary right can itself be described as property.
W68-00590

THE RIPARIAN RIGHT AS PROPERTY--MODIFICATION OF THE RIPARIAN DOCTRINE,
Theodore E. Lauer.
In Water Resources and the Law, pp 255-263, 1958. Michigan Univ. Law School, Ann Arbor, 9 p, 14 ref (see W68-00581).

Descriptors: *Riparian rights, *Legislation, *Judicial decisions, Water policy, Social needs, Water law.
Identifiers: Private property, *Property rights, Constitutional law.

The author believes that sufficient statutory changes can be made within the framework of the traditional riparian doctrine to enable optimum use of water resources. The premise of this view is that the courts will accept the proposition that particularized rules governing the right of the riparian owner to use water are not themselves property and therefore can be modified or revoked, providing only that they are replaced by other rules of use which are reasonably calculated to accord each riparian owner equality of opportunity for optimum water use. However, if the courts determine that the precise rules of water use are as much private property as the basic right to the use of water, then additional problems arise. Change could come from one of three sources: the courts, the legislature, or through constitutional amendment. After examining the particular legal problems which arise in respect to each source of change, the author concludes that judicial modification should not be heavily relied upon, legislation providing the best alternative. If both of these fail, then constitutional modification should be resorted to when there is a great public need.
W68-00592

THE RIPARIAN RIGHT AS PROPERTY--CONCLUSION: THE EFFECT OF THE MODEL WATER USE ACT UPON THE RIPARIAN DOCTRINE,
Theodore Lauer.
In Water Resources and the Law, pp 264-268, 1958. Michigan Univ. Law School, Ann Arbor, 5 p, 4 ref (see W68-00581).

Descriptors: Riparian rights, *Legislation, Administrative agencies, Hydrologic cycle, Water permits.
Identifiers: *Permit system, *Model Water Use Act.

The author finds that the Model Water Use Act, set forth elsewhere in the book, does not destroy the 'vital principle' of the riparian system, which is the recognition and enhancement of the equal right to water use possessed by each person having access to a source of water. The goals of the riparian doctrine and the Model Act are fundamentally the same: beneficial use of all the water resources of a state; a just measure of economic certainty for water users; and a practical, expedient method for administrating the legal system. Whereas the riparian system fails to meet these goals, it is hoped that the Model Act will achieve them. Thus the provisions of the Model Act for an integrated approach to all water uses, in accordance with scientific knowledge of the hydrologic cycle, a permit system, and agency rather than judicial administration of the water use system should be upheld by the courts.
W68-00593

MODEL WATER USE ACT WITH COMMENTS,
Dominic King, Theodore Lauer, and Wilbert L. Ziegler.
In Water Resources and the Law, pp 533-614, 1958. Michigan Univ. Law School, Ann Arbor, 92 p, append (see W68-00581).

Descriptors: *Legislation, Administration, *Administrative agencies, Administrative decisions, Water pollution, *Water utilization, *Water permits, Adjudication procedure, Beneficial use, Preferences (Water rights), Water law, Water rights, Water transfer, Domestic water, Municipal water, Remedies.
Identifiers: *Model Water Use Act, Water Resources Commission, Permit system.

The introduction sets forth six basic principles which guided the formulation of the Model Water Use Act. The Act itself encompasses all water resources of a state. Although diversions and uses being made at the time of the passage of the Act are recognized and protected, no use may be initiated after the passage of the Act without a permit from the Water Resources Commission, a regulatory agency in charge of administering the Act. The Act spells out the powers of the Commission, enables it to issue rules and regulations, establishes procedure for hearings, and provides for judicial review. Domestic uses are exempted from all but the emergency provisions of the Act. All uses of water under the Act are subject to the standard of wise beneficial use. Discontinuance of a use may result in its ceasing to be legally recognized. In times of emergency, the available supply of water is apportioned or rotated among all or some of the users according to the criterion of most beneficial use. Water pollution is also brought under the permit system.
W68-00604

PRESCRIPTIVE WATER RIGHTS IN WISCONSIN,
U of Wisconsin, Madison.
Richard S. Harnsberger.
Wis L Rev, Vol 1961, No 1, pp 47-81, Jan 1961. 35 p, 170 ref.

Descriptors: *Wisconsin, Remedies, Beneficial use, Consumptive use, Natural use, *Reasonable use, Irrigation, Irrigation practices, Water allocation (Policy), Water law, *Water policy, Water supply, Legal aspects, Legislation, Judicial decisions, Natural flow doctrine, *Prescriptive rights, Riparian rights, Appropriation, Social needs.

Prescriptive water rights in Wisconsin are discussed as one means of getting around the rigidity of the riparian doctrine. Prescriptive rights are gained through a long, continued, adverse use. In Wisconsin the period of such use is twenty years unless the right is acquired in connection with a milldam, in which case the period is ten years. Wisconsin follows the reasonable use doctrine of riparian rights as opposed to the natural use doctrine. Reasonable uses include irrigation on riparian land, non-riparian use in the cranberry industry, and municipal uses. The elements necessary to give rise to a prescriptive right are adverseness, notoriousness, open claim of title, and continuous use. There are several limitations on acquisition of prescriptive rights. Prescriptive rights cannot be exercised for or against the state, to maintain a nuisance, against the public, or as to diffused surface water. When there is an intent to abandon, prescriptive rights can be lost. It is questionable whether comprehensive water law measures will eliminate prescriptive rights, or whether they will remain as an exception to recording acts similar to adverse possession.
W68-00613

WASSEBURGER V COFFEE (CONFLICT IN WATER DEMANDS RESULTING FROM WATER DIVERSION).
180 Neb 149, 141 N W 2d 738-748 (Neb 1966).

Descriptors: *Riparian rights, Prior appropriation, Beneficial use, Priorities, Diversion, *Reasonable use, *Statutes, *Remedies, Riparian land, *Appropriative rights, Stock water, Irrigation water, Competing uses, Natural use.
Identifiers: Injunction.

Riparian owners received an injunction against upper irrigators to stop their exhausting stream beds by diversion. The Irrigation Act of 1895 abrogated the common-law system of riparian rights and replaced it with a statutory scheme based on prior appropriation. But traits riparian at the time of the Act's passage remain unaffected by it. The Supreme Court of Nebraska remanded this case to have additional evidence adduced on the history of the titles to the lands. It continued, however, to discuss the controversy, commenting on the incompatability of riparian and appropriative rights, and defining the text of liability for invasions against riparian owners. An appropriator is deemed liable to a riparian proprietor only if the harmful appropriation is unreasonable in respect to the proprietor. To defeat a finding of unreasonableness, the utility of the appropriation must outweigh the gravity of the harm to the proprietor. Criteria, such as priority of appropriation or riparian use, were used, by the court, to guide in determining which party has the riparian interest in the water. The court concluded that plaintiffs' interest in watering their livestock outweighed defendant's need to irrigate. An injunction was viewed as a proper remedy.
W68-00618

TENNESSEE GAS TRANSMISSION CO V MOORHEAD (RIPARIAN RIGHTS RELATING TO RIVER DIVERSION).

405 S W 2d 81-86 (Tex Ct App 1966).

Descriptors: *Texas, Riparian rights, Riparian land, Diversion, Legal aspects, *Alteration of flow, Severance, Judicial decisions, Damages.

This is an action for damages to plaintiff's land because of a diversion of a river by the defendant from plaintiff's land. The Texas Court of Civil Appeals held that a 1949 agreement which gave the defendant the right to a limited diversion of the river from plaintiff's land did not give the defendant the right to so divert the river 12 years later that it no longer abutted plaintiff's land. Where an act is wrongful and done intentionally in violation of the rights of the plaintiff, exemplary damages may be awarded, and no evil intent need be shown.
W68-00620

LABOUNTY V VICKERS (RIPARIAN RIGHTS GAINED BY EASEMENT TO RIVER BOUNDARY).
352 Mass 357, 225 N E 2d 333-342 (1967).

Descriptors: *Massachusetts, Legal aspects, Judicial decisions, Shores, Beaches, *Boundaries (Property), Easements, Access routes, Natural use, Reasonable use.
Identifiers: Dominant estate, Servient estate.

Where a strip of land laid out as an access road was extended on a subdivision plan to the high water mark of a river, it is a reasonable inference that the

grantor who reserved the easement intended to put the land so reserved to a use which was natural for the type of land reserved. It is not necessary that the plans indicate in so many words that the shore was to be used for beach purposes. When an easement is created by deed, but its precise limits and location are not defined, the location and use of the easement by the owner of dominant estate for many years, acquiesced in by the owner of the servient estate, will be deemed to be that which was intended to be conveyed by the deed.
W68-00633

THE BRANDYWINE PLAN,
U of Penna, Phila; Regional Science Research Institute, Phila; U S Geological Survey, Dept of Interior, Wash.
John C. Keene, Ann L. Strong, and Robert E. Coughlin.
Chester County Water Resources Authority, April 1968, 28 pp. 3 map, 6 illus, 27 photo, 5 dwg, 1 append.

Descriptors: Urbanization, Community development, Drainage systems, Land use, Storm runoff, Water resources development, Land Tenure, Management, Real property, Legislature, Water resources development.
Identifiers: Brandywine, Chester Co, Penna, Conservation easements.

The plan is a proposal for the wise use of the water and land resources of the Upper East Branch of Brandywine Creek, Chester County, Pa. The plan was developed for the Chester Co Water Resources Authority by the Institute for Environmental Studies, University of Penna; Regional Science Research Inst; U S Geological Survey; and their consultants. The aim of the Plan is to prevent deterioration of the water resources and thus to retain the amenities of related land when urbanization occurs in the Brandywine watershed. The Plan recommends 3 types of action: public purchase of conservation easements or other less than fee interests on flood plains, stream and swale buffers, steep slopes and forests; development and adoption of detailed water supply and sewage disposal plans in advance of urbanization; and enactment of strong local regulations for erosion and storm runoff control.
W68-00654

6E. Water Law and Institutions

1968 KANSAS LEGISLATION OF WATER.

Kans Water News, Vol 11, No 3, p 8, Apr 1968. 1 p.

Descriptors: *Legislation, Water law, Water allocation (Policy), Mining, *Reclamation, Strip mines, *Water districts, Administration, Management, Evapotranspiration, Laboratories, Projects, *Research facilities, Water resources development, Kansas.
Identifiers: Mined-land conservation, Groundwater districts, Water resources research, Operator permits, Aquifers allotments.

The Kansas State Legislature in 1968 passed a Mined-Land Conservation Reclamation Act. The Act defines reclamation to be the preparation of land for forest, grasses, crops, wildlife, and aquatic resources, or for recreational and industrial uses. A board was created to regulate surface mining activity. The Act defines water districts, prescribes the powers of its administrative officials, and defines the areas and scope of operations in a district. Because evapotranspiration is the largest user of Kansas water, $150,000 was appropriated to set up a research center at Kansas State University to investigate means of reducing such water losses which are critical to the State and much of the world.
W68-00322

STATUS OF FEDERAL WATER POLLUTION CONTROL LEGISLATION,
Water Pollution Control Federation, Washington, DC.
Robert A. Canham.
Water Pollution Control Federation J, Vol 38, No 1, pp 1-8, Jan 1966. 8 p.

Descriptors: *Legislation, *Water pollution control, Water Resources Planning Act, Administrative agencies, Water resources development, Coordination, Planning, *Federal government, *Water policy, Administration.

Major Federal legislation of 1965 affecting water pollution is reviewed. Law 89-234 established a national policy for the prevention, control and abatement of water pollution. It established the Federal Water Pollution Control Administration within the Department of Health, Education, and Welfare, thus relieving Public Health Service responsibility for water pollution control. The definition of water subject to enforcement of Federally approved standards remain the same. New enforcement procedure is reviewed. Grants to state and local governments for combined wastewater research and development are provided. Other significant water pollution legislation of 1965 includes: (1) Housing and Urban Renewal Act, providing Federal assistance to local governments in construction of public water and sewer works, (2) Farmers Home Administration Act to assist in construction of rural water and waste disposal systems, (3) Public Works and Economic Development Act, (4) Water Resources Planning Act. Probable future legislation will provide: (1) tax on polluters, (2) financial aid to industry, (3) increased funding for sewer and stormwater projects, (4) move of the Water Pollution Control Administration to another agency.
W68-00404

WEIMER V GILBERT (BOUNDARY DISPUTE CONCERNING LAKE FRONT PROPERTY RIGHTS).
7 Mich App 207, 151 NW 2d 348 (1967).

Descriptors: *Boundaries (Property), *Michigan, *Boundary disputes, Highwater mark, Lakes, Lake beds, *Lake shores.
Identifiers: *Deeds.

This is an action to reform a deed. Plaintiffs bought a 'lake lot' on Marble Lake in Michigan. The boundaries of this lot were described in the deed as 'commencing on the shore of Marble Lake at a point...' The point on the shore was described by reference to a fixed marker. Subsequent to plaintiff's purchasing the land, the lake level receded, and a neighbor filled in the land between the fixed point and the new water's edge, cutting off plaintiff's access to the lake. The court reformed the deed to conform to the intent of the parties that the shore of the lake, and not a fixed line, should be the plaintiff's boundary.
W68-00405

OWNERSHIP OF BEDS OF NAVIGABLE WATERS,
Jaime E. Diaz.
Tul L Rev, Vol 30, No 1, pp 115-129 Dec 1955. 15 p, 91 ref.

Descriptors: *Louisiana, *Ownership of beds, *Submerged lands, Beds under water, Civil law, State government, Legislation, Judicial decisions, Navigable waters.

In California Co v Price, 225 La 706, 74 S 2d 1, (1954), the Louisiana Supreme Court held that the bed of a navigable arm of the sea was susceptible of private ownership if acquired by state patent prior to 1921. Since the La Constitution of 1921, the state may not convey the beds of navigable waters. Article 482 of the La Civil Code classifies things as common, public, or private. Common things are inherently insusceptible of private ownership. Public things are insusceptible of private ownership if private ownership is incompatible with public purpose. The California Co case did not refer to article 482. La Act 62 of 1912 (La RS of 1950, 56:421) provided a six year perscriptive period for the state to annul or vacate patents. Therefore, the court held that a state suit to annul the patent was barred. The 1954 La legislature attempted to reverse the California Co case by the passage of Act 727. (La RS 9: 1107-1109), stating that the 1912 act did not intend to cure patents to beds of navigable waters, and declaring all such patents null and void. This is probably unconstitutional under both the United States and La Constitutions.
W68-00406

OWEN V YOUNT (RIGHT OF ACCESS TO LAKE FRONT OVER DRAINAGE EASEMENT LAND).
198 So 2d 360 (2nd DCA Fla 1967).

Descriptors: *Easement, *Florida, Riparian rights, *Land use, Public rights, Public lands, State government, Legal aspects, Real property.
Identifiers: Drainage easement.

This question concerns the use of a parcel of land dedicated as a drainage easement on the original plat. In 1956, defendant bought a lakefront lot and later the plaintiff bought a non-lake front lot in the same subdivision. In 1962, the defendant purchased the land in question which the plaintiff and others used as an access to the lake. For 4 years after 1962 the plaintiff continued to use the land for access to the lake. Then the defendant closed the access and the plaintiff brought action to enjoin the defendant from interfering with the plaintiff's right of access. The Court held that the land had been dedicated as a drainage easement and persons who buy fee simple title to land clearly impressed with an easement buy only a servient interest in the land clearly inferior to the dominant interest of the easement. The use of the easement for reasonable access to the lake is a valid secondary use by the plaintiff so long as it does not impair or interfere with the easement's primary use for drainage purposes.
W68-00407

MOORE V KULJIS (OWNERSHIP OF LAND MADE AVAILABLE BY ARTIFICIAL ACCRETION).

207 So 2d 604 (Miss 1967).

Descriptors: *Accretion (Legal aspects), *Mississippi, Beds under water, Ownership of beds, Boundaries (Property), Navigable waters, Riparian rights, Riparian lands, State government, Legal aspects, Water law.

The controversy is over the ownership of land made by artificial accretion. In 1932, one Mladinich owned a parcel of land described as being bounded on the west by Cedar Street and on the south by the Gulf of Mexico. Sometime between 1936 and 1943 the Federal Government dredged and pumped several hundred feet of accretion on the south end of the street and the land. In 1943, Mladinich sold that portion of land that had been built up to the south of his original lot to Williams. The land in dispute is the east half of the property that would have been Cedar Street if it had been extended. In 1958, Williams sold his land to the plaintiff. In 1962, Williams quit-claimed his interest in the disputed property to the principal defendant. The Court held that filled area added to the land of an upland owner by artificial accretion made by a stranger, accrues to the upland owner and a street or public highway leading to navigable waters, such as Cedar Street, will keep pace with the extension of the land by artificial filling. The Court also held that accretions could deprive the state of its title to the previously submerged lands.
W68-00410

TITLES TO MARSHLANDS IN SOUTH CAROLINA PART I,
SC Bar Association and U of SC School of Law, Columbia.
John M. Horlbeck.
SCLQ, Vol 14, No 2, pp 288-333, Winter 1962. 46 p, 256 ref.

Descriptors: *South Carolina, *Ownership of beds, *Marshes, Judicial decisions, Legislation, Administrative agencies, Coastal marshes, *Tidal marshes, Boundaries (Property), State government, Submerged Lands Act.
Identifiers: *Tidelands, Common law, Grants (Land), Sovereignty lands.

The purpose of this article is to explore the history and status of marsh or tidelands in South Carolina. Terms relating to ownership and boundaries of marshlands are defined. The English Crown's sovereignty over and power to grant marshlands passed to the state of South Carolina after the revolution. The common law of marshland ownership and South Carolina statutes dealing with private ownership of marshlands and the power of various state agencies to deal with marshlands are explained. The significance of the Federal Submerged Lands Act 32 USCA Secs 1301-43 (1964), is noted. South Carolina court decisions relating to grants, prescription, riparian rights, and navigability of tidal streams are analyzed with reference to marshland ownership. Title to marshlands may be obtained by grant from the sovereign, prescription, (against both the state and private owners), possession, and usage. This article contains 256 references. This abstract is of the first part of a two part article in the South Carolina Law Quarterly.
W68-00412

TITLES TO MARSHLANDS IN SOUTH CAROLINA PART II,
SC Bar Association and U of SC School of Law, Columbia.
John M. Horlbeck.
SCLQ, Vol 14, No 3, pp 335-364, Spring 1962, 30 p, 89 ref.

Descriptors: *South Carolina, *Ownership of beds, *Tidal marshes, Boundaries (Property), Highwater mark, Low water mark, Navigable waters, *Marshes, Non-navigable waters, Judicial decisions, Coastal marshes, Tidal waters, Salt marshes.
Identifiers: *Public trust doctrine, *Tidelands, Grants (Land), Common law, Sovereignty lands.

This abstract is of the second part of a two part article in the SCLQ. At common law all waters subject to the flow of the tides were navigable. In South Carolina the test of navigability is navigability in fact. The general rule is that land granted in navigable water extends only to the mean high water mark, and that land below the mean low water mark is held by the state in trust for public purposes. Marshlands fall between the high and low water marks. In South Carolina marshlands were historically regarded as 'vacant lands' and were granted and used by the grantees. Such grants were presumed valid with the burden on the party challenging the grant's validity. Much of the confusion as to title to marshlands stems from the Cape Romaine case, 148 SC 428, 146 SE 434 (1928), which went beyond the agreed issue of title to the beds of navigable streams and declared that title to the beds of non-navigable tidal streams and marshlands was held by the state in trust for public purposes. The article severely criticizes the holding in the Cape Romaine case, as destroying certainty in South Carolina property law.
W68-00413

CLAUDIO V VILLAGE OF GREENPORT (RIGHT TO USE OF SUBMERGED LAND).

28 App Div 2d 1140, 284 N Y S 2d 965 (1967).

Descriptors: *Ownership of beds, Administrative decisions, *Judicial decisions, *Legislation, Public rights, Public benefits, Reasonable use, Prescriptive rights, Riparian rights, Water law, *New York, Docks.
Identifiers: Constitutional law, Public trust doctrine.

Plaintiff Caludio brought an action against the Village of Greenport for determination of a claim adverse to the plaintiff's title to certain lands under the waters of the Peconic Bay. The plaintiff's claim was to a wharf extending into Greenport Harbor. The New York legislature had authorized the commissioners of the land office to convey the subject premises to the plaintiff's predecessor in title. After receipt of title, the plaintiff placed barriers on the premises, which the village removed. The court held that the statute authorizing the sale was not constitutional. Land under the waters of the bay is held by the State of New York in trust for the people of the State. The State may properly convey its lands to private persons or corporations for some public purpose or reasonable use for the public benefit. After reviewing and rejecting other grounds argued by the village, the court held, as the the village's contention that prescriptive rights were acquired by the public, that the general rule is that the unorganized public cannot acquire rights by prescription through use alone.
W68-00414

TOWN OF GUILDERLAND V SWANSON (USE OF CAUSEWAY EXTENDING OVER MUNICIPALLY-OWNED POND BED).

286 NYS 2d 425 (App Div. 1968).

Descriptors: *Ownership of beds, *Boundaries (Property), Beds under water, Local governments, *Judicial decisions, *New York, Ponds, Construction.
Identifiers: Causeways, Continuing trespass.

Plaintiff brought an action to enjoin a continuing trespass. The primary issue was the ownership of the bed of the pond, which adjoined plaintiff municipality's land on the south and defendant's on the north. The trial court found that earlier conveyances in defendant's chain of title, by reference to the 'side' of the pond, the 'water's edge' and courses 'along' such pond, excluded from defendant's title the bed of the pond. In contrast the court found that a mortgage in plaintiff municipality's chain of title, describing the plaintiff's land as 'all water and land under water appurtenant to the premises,' was clearly intended to include the pond bed. While recognizing defendant's continuing trespass, the court refused to grant a mandatory injunction on the ground that the acts of officers of plaintiff, in failing to voice any objection to construction of the causeway for more than two years after its completion, encouraged defendants to construct the causeway. The appellate court modified the judgment so as to enjoin use of the causeway by any person other than plaintiff town, its grantees, licensees, and permittees, thereby relieving plaintiff's concern as to possible accrual of rights by adverse possession.
W68-00416

HALE V SOUTHWEST ARK WATER DIST (PUBLIC USE OF A CANAL ACROSS CONDEMNED RIGHT-OF-WAY).

244 Ark 647, 427 SW 2d 14 (1968).

Descriptors: *Arkansas, Easements, Eminent domain, Right of way, Water utilization, Condemnation, Water districts, Industrial plants, Legal aspects.

The main question in the action to condemn right-of-way for pipelines and a canal to transport water from a reservoir was whether the proposed use was for the public. The water district proposed building a canal from its reservoir to a paper company. The proposed canal was large enough to serve all expected needs south and west of the reservoir. The paper company would be the only customer served at first but the water district was obligated to serve any member of the public desiring its services. Since the canal was not for the exclusive use of the paper company, the court held the proposed use to be public and authorized by the state constitution.
W68-00417

MOYER V STATE (RIPARIAN RIGHTS IN CHANNEL IMPROVEMENT BY DREDGING AND LANDFILL).
289 NYS 2d 114 (Ct Cl 1968).

Descriptors: *Judicial decisions, *New York, Navigable waters, *Riparian rights, Navigation, Dredging, Channel improvement, Landfills, Compensation, Appropriation, State governments, State jurisdiction, Remedies, Docks.

Claimants purchased lots having frontage on a navigable bay. They dredged the channel of the bay in front of their property so that it could be used by boats. The material so removed was used to fill land under water adjacent to their lot lines to make land on which to construct the boathouse and piers being used by them in a marina business when appropriated by the State of New York. Claimants did not obtain permission from the State to fill the land or to build the boathouse and piers. One right of claimants as riparian owners was the right to build the boathouse and piers on the land under water without a grant from the State, so long as the improvements were for the use of navigation and commerce connected with a business or individual use. Here the improvements not only did not interfere with navigation but in fact improved it. Under these circumstances, the court held that claimants were entitled to compensation from the State for property, including the boathouse and piers, taken from them by the State.
W68-00418

ELWOOD V CITY OF NEW YORK (RIPARIAN RIGHTS IN ALTERATION OF NATURAL FLOW OF RIVER).
271 F Supp 62 (SDNY 1967).

Descriptors: *Alteration of flow, Natural flow, Water law, Legal aspects, Riparian rights, Riparian lands, Diversion, Navigable rivers, *Pennsylvania.

The plaintiff asked for a summary judgment in an action for damages for diversion of river waters from his farm. The court held that under Pennsylvania law a riparian owner can assert a claim for damages by reason of the interference with the natural flow of a stream by upstream owners. The court ordered a trial on the merits because there were questions of fact as to whether the river was navigable at the location of the plaintiff's property and as to the plaintiff's interest and damages.
W68-00419

...MINNESOTA WATERSHED DISTRICT WITH POWER TO ASSESS...PROPERTY IS CONSTITUTIONAL.
Ely, Duncan and Bennett, Wash., DC.
Northcutt Ely.
Nat Res J, Vol 5, No 2, pp 216-217, Oct 1965. 2 p, 9 ref.

Descriptors: Watersheds (Basins), *Watershed protect. and flood prevent., Federal government, Federal project policy, *Minnesota, State governments, Water districts, Water law, Water resources, *Water resources development, Easements, Eminent domain, Judicial decisions, Legal aspects, Legislation, Right-of-way, Assessments, Projects.
Identifiers: Constitutional law.

The Supreme Court of Minnesota's ruling on the constitutionality of the Minnesota Watershed Act is discussed. This statute enabled federal aid to come into the state by creating local districts to contract with the federal government under the

Watershed Protection and Flood Prevention Act. The federal act conditions the undertaking of any project on local cooperation. Property assessments must be levied to provide easements and rights-of-way. The Minnesota Supreme Court held that this enabling legislation was not an unconstitutional exercise of legislative powers. This was consistent with decisions in other jurisdictions. It is concluded that it had become increasingly important for the states to participate in intergovernmental development programs, and that the cooperation in this instance was essential to the development of the nation's water resources.
W68-00423

SOME PRINCIPLES OF WATER LAW IN THE SOUTHEAST,
School of Law, Mercer University, Macon, Georgia.
Royal G. Shannonhouse.
Mercer L Rev, Vol 13, No 2, pp 344-355, Spring 1962. 12 p, 83 ref.

Descriptors: Boundaries (Property), Civil law, Judicial decisions, Natural flow doctrine, Overlying proprietor, Ownership of beds, Prescriptive rights, Repulsion (Legal aspects), Riparian land, Ponds, Riparian rights, *Watercourses (Legal), *Surface runoff, *Southeast U. S., *Water law, Lakes, Usufructuary right.
Identifiers: Civil law rule.

A general survey is presented of some basic principles respecting the use of natural, non-navigable watercourses on and below the earth's surface and judicial rules on diffuse surface waters, lakes and ponds in the Southeast. Watercourse is defined, and the extent of title to land bounded by a watercourse is discussed. Riparian rights in general are set forth, concluding that the right of riparian owners to enjoy the natural flow of the watercourse, unimpaired in quality and quantity except to the extent necessarily resulting from a reasonable use by other riparian owners, is recognized by all Southeastern states. The law pertaining to natural and artificial obstructions, an aspect of the natural flow doctrine, is analyzed. The law of diffuse surface water is controlled in the Southeast by the common enemy and civil law doctrines. Cases supporting and modifying these doctrines are examined, along with their application to urban landowners. The rights of littoral owners in non-navigable lakes and ponds is discussed. The article concludes that something other than the riparian system is needed for the best utilization of water supplies.
W68-00428

MATTHEWS V MCGEE (ACCRETION AND AVULSION RIGHTS BY THALWEG CHANGE OF RIVER BOUNDARIES).

358 F 2d 516 (8 Cir 1966).

Descriptors: *Accretion (Legal aspects), *Avulsion, Riparian rights, Riparian land, Banks, Channels, Thalweg, Boundaries (Property), State government, Real property, Water law, Legal aspects.

The controversy involved a parcel of land known as Diamond Point which changed from the southern to the northern bank of the Arkansas River. The main question was whether the change was a result of accretion or avulsion. The plaintiff owned land to the north of the river in Jefferson County and the defendant owned land to the south in Lincoln County. The court held that the plaintiff's evidence was sufficient to warrant a finding by the trial court that the change occurred by accretion. When the thalweg of a river forms the boundary between two counties, a change in the thalweg changes the boundary if the change is the result of accretion but not if it is a result of avulsion. The accretion became the property of the plaintiff.
W68-00430

UNITED STATES V 531.13 ACRES OF LAND (RIPARIAN RIGHTS ALTERED BY DAM CONSTRUCTION).
366 F 2d 915 (4 Cir 1966).

Descriptors: *Riparian rights, *Water utilization, *Natural flow, *South Carolina, Navigable waters, Non-navigable waters, Water pollution, *Eminent domain, Condemnation, Waste disposal, Federal government, Water pollution control, Reasonable use, Judicial decisions.
Identifiers: Commerce clause, *Sovereignty lands.

The controversy involves two eminent domain cases. In the first, J. P. Stevens and Co. claims compensation for the loss of its waste disposal use of the Seneca River. In the second, Duke Power Company claims compensation for the loss of water power of the Seneca River. Both claimants were riparian owners deprived of their use by the construction of a dam. The Court held that no absolute right was vested in Stevens under the law of South Carolina to discharge industrial wastes into the Seneca River. Utilization of streams is subject to the rights of other riparian owners, enforcable by them or the Pollution Authority. In fact, the state banned Stevens's use of the river and the ban created no obligation on the United States to make good the loss. In considering the Duke claim, the court held that the Seneca River is subject to the control of the Government as a tributary, though non-navigable, of the navigable Savannah under the Commerce Clause. The United States may appropriate the flow of either a navigable or non-navigable stream pursuant to its power under the Commerce Clause without paying any compensation.
W68-00432

ALEXIS V KARE-SUE, INC (WATER DISTRICT'S AUTHORITY TO SELL PUBLIC LAND).

187 So 2d 476-478 (4 Cir Ct App La 1966).

Descriptors: *Louisiana, *Water district, Public land, State governments, Local governments, Legal aspects.

The question in the declaratory action was whether a water district acted ultra irres in selling property acquired as public land at a private sale without special authority from the legislature. The court held that the water district had full and complete legal authority and capacity to sell their idle and surplus real property at private sale to a private corporation, notwithstanding there was no express or special authority as such in the constitution or statutes. Such corporate subdivisions of the state not only have the authority to sell, but have the duty to sell and dispose of excess real property; and it is not necessary for the legislature to say so in a special enactment.
W68-00434

RANDS V U S (CONDEMNATION VALUE OF LAND AS A PORT SITE).
367 F 2d 186-193 (9th Cir 1966).

Descriptors: *Condemnation value, Land appraisal, Eminent domain, Condemnation, Riparian rights, Riparian lands, Water utilization, Navigable waters, Federal Government, Natural flows, Water law, Legal aspects.
Identifiers: Commerce Clause, Navigation servitude.

The question in the condemnation suit involved whether the United States must pay a riparian owner the value of his land as a port site. The Court held that the riparian land owner has a property right of access from the front of his land to the navigable part of a stream and may construct landings, wharves or piers for this purpose. Even though the right is subject to the government's navigation servitude, it is a valuable right and the owner should be compensated for the loss of that right.
W68-00435

ORANGE CITY WATER CO V TOWN OR ORANGE CITY (STATE REGULATION OF PRIVATE WATER AND SEWER SYSTEMS).

188 So 2d 306-309 (Fla 1966).

Descriptors: *Florida, Legal aspects, *Sewage, *Artificial water courses, Water delivery, Legislation, State governments, Local governments, *Utilities.

The question was whether, when a board of county commissioners had invoked the provisions of Fla. Stat. Ch. 367 (1965) bringing the water systems of the county under the jurisdiction of the Florida Public Utilities Commission, the board's subsequent repeal of such resolution had the effect of ousting such jurisdiction. The Court held that a resolution repealing the resolution adopting Chapter 367 was of no legal effect and did not oust the jurisdiction of the Florida Public Utilities Commission to regulate privately-owned water and sewer systems in the county.
W68-00436

ANDERSON--TULLY CO V WALLS (LAND OWNERSHIP BY AVULSION BOUNDARY CHANGE).
266 F Supp 804 (ND Miss 1967).

Descriptors: *Avulsion, *Accretion (Legal aspects), *Bank erosion, *Boundaries (Property), *Thalweg, Cutoffs, State government, Riparian lands, Riparian rights, Navigation, Navigable waters, Ownership of beds, River beds, Real property, Water law, Legal aspects.

The question involved the ownership of a parcel of land called Lunar Bar. The plaintiff owned land in Mississippi formed by a horseshoe bend in the Mississippi River called Carter Point. The defendant owned land in Arkansas across from Carter Point. Lunar Bar was formed by alluvion and was at all times attached to Carter Point or an island on the Mississippi side of the thalweg. In 1955, a cutoff was opened across the neck which joined Carter Point to the mainland. The cutoff caused an avulsion which left the old riverbed dry. The court held that when a navigable river forms a boundary between states, the thalweg is to be taken as the true boundary and when the course of the river is changed by an avulsion, the boundary does not change but remains in the middle of the old channel. The owner of riparian lands in Mississippi holds title to the bed of the river extended to the thalweg subject only to the superior rights of navigation. Therefore the plaintiff owned Lunar Bar and his ownership did not change as a result of the avulsion.
W68-00437

U S V HARRISON COUNTY (OWNERSHIP OF BEACH PROPERTY BY ARTIFICIAL ACCRETION).
265 F Supp 76 (S D Miss 1967).

Descriptors: *Accretion, *Mississippi, Riparian rights, Riparian land, *Easement, Public rights, Ownership of beds, Navigable water, Legal aspects, Water law, Real property, Land tenure.

The question involves the ownership of beach property made by artificial accretion. Harrison County, Mississippi, with a contribution from the Federal Government, filled a 26 mile stretch of shoreline and created a beach approximately 300 feet wide. The primary intent of the filling was to protect a seawall that had been previously erected to protect interstate Highway 90 and the secondary intent was to provide a beach for individual public use. For some time the public did use the beach until the abutting landowners obtained police aid in keeping the public away. The Federal Government brought action maintaining that there was a recreational easement over the beach for individual public use. The court held that under the doctrine of artificial accretion the beach pumped in without any participation by the abutting property owners

insured to the respective abutting owners whose properties front on the water. The county did not get an easement over the beach property nor did the state obtain ownership of the property created.
W68-00438

WATERS AND WATERCOURSES-EXTENT OF RIPARIAN LAND-COMPENSATION ON CONDEMNATION,
Michigan Univ., Law School, Ann Arbor.
Gerald M. Stevens.
Mich L Rev, Vol 36, pp 346-348, Dec 1937. 3 p, 15 ref.

Descriptors: *Condemnation, Eminent domain, Condemnation value, Compensation, *Riparian land, *Riparian rights, Remedies, Legal aspects, Water law.

On eminent domain cases where only a part of a tract is taken the usual rule of damages allows recovery for the value of the land taken and any reduction in value of the remaining part. Where riparian land is condemned, damages for loss of water rights can be recovered only with regard to the riparian land. There can be no recovery for a decrease in value of non-riparian land, in proximity to the riparian land, caused by the loss of these water rights. Three conflicting tests have been used to determine the extent of riparian land in a single tract. Under the unity of title test, if A owns a tract of land, a portion of which is riparian, the whole tract is riparian. The source of title test produces a different result. If B sold non-riparian land which bordered on A's riparian land to A, the land sold by B would remain non-riparian even though all the land is now owned by A as a single tract. If the government survey test is applied, riparian incidents attach only to the smallest subdivisions of the government survey.
W68-00439

BURFORD V VILLAGE OF LA GRANGE (FLOOD DAMAGE TO PRIVATE PROPERTY BY MUNICIPAL DRAINAGE SYSTEM).
90 111 App 2d 210, 234 NE 2d 120 (1967).

Descriptors: *Illinois, Drainage systems, Drainage engineering, Drainage water, *Storm drains, Cities, Legal aspects, Local governments, *Remedies, *Floodwater.

This was an action by property owners against a village to recover damages sustained by reason of flood. A spur drain on plaintiff's property connected with a sewer controlled by the village. Plaintiff alleged that defendant's negligence in maintenance and inspection of the sewer system was the cause of flood damage to his home. The Court recognized the rule that where a municipality assumes control over a sewer or drain constructed by a private person that it will be held liable for negligence in its operation but refused to find the defendant-village liable since: (1) faulty, inadequate and insufficient basement construction contributed no small part to the damages sustained; (2) the damage was occasioned by a deluge and would have occurred irrespective of any negligence on the part of defendant; (3) plaintiff had contributed to his damage by blockage of the spur drain; (4) there was no evidence to show that defendant had assumed control or management of the spur system; and (5) there was no evidence to show that the sewer system was inadequate to handle ordinary rainfall.
W68-00441

CUMMINGS V BOYLES (OWNERSHIP OF LAND IN A RIVER ALTERED BY A FLOOD).
411 S W 2d 665 (Ark 1967).

Descriptors: *Accretion (Legal aspects), Navigable rivers, Avulsion, *Arkansas, Boundaries (Property), Real property, Channels, Thalweg, Legal aspects, Water law, Riparian land, Riparian rights.

The question involved the ownership of an island in the Arkansas River. The plaintiff owned the S 1/2 of the NW 1/4 of Section 33 and the river ran partially through the northern portion of his land. The island in question was located partially within the plaintiff's boundary lines. The plaintiff claimed that the island had been formed by accretion and was attached to his land until a flood in 1957 cut a channel which separated the island from the mainland. The Supreme Court agreed with the trial court in finding that the island was not formed by accretion but had been in existence for at least 97 years. The court held that the plaintiff owned only that portion of the island embraced within the description of his deed and any accretions to that portion.
W68-00443

MEHLBURGER V NORWOOD (OWNERSHIP OF LAND ALTERED BY ACCRETION AND ABRUPT STREAM CHANGE).
420 S W 2d 81 (Ark 1967).

Descriptors: *Accretion (Legal aspects), *Boundaries (Property), Real property, Navigable waters, Riparian land, Riparian rights, Water laws, Legal aspects, *Arkansas.

The question involved the ownership of a peninsula of land extending from the plaintiffs' land downstream in front of the defendant's land. The parties owned land that was originally bounded by the Arkansas River. A stream running perpendicular to the Arkansas River separated the two tracts. The plaintiff contended that the peninsula gradually formed as an accretion attached only to their tract and extended southward forming the channel of the stream to bend to the south so that the stream continuously separated the peninsula from the defendants' property. The trail court found that the accretion began to form against the land of both parties and that after 1948, the stream abruptly changed its course, cutting through the accretion so that the accreted lands attached to the defendant's tract were left between the stream and the river. The Supreme Court found that the evidence supported the trial court's finding and held that the part of the peninsula across from the defendant's land belonged to him.
W68-00444

NATIONAL WATER RESOURCES POLICY ISSUES,
Irving K. Fox.
Law and Contemp Prob, Vol 22, No 3, pp 472-509, Summer 1957. 38 p, 157 ref, disc.

Descriptors: *Irrigation programs, *Flood control, *Hydroelectric power, *Municipal water, *Industrial water, *Cost-benefit ratio, Irrigation efficiency, Comparative benefits, Comparative costs, Cost repayment, Cost sharing, Economic efficiency, Social values, Federal government, Project purposes, Water resources development.

The article is a comparison of the reports of 5 major National Water Resource Study groups to identify and define some of the significant water resource policy issues. The 5 groups selected were: (1) President's Water Resources Policy Commission (1950); (2) Missouri Basin Survey Commission (1953); (3) 2nd Hoover Report (1955); (4) Task Force Report on Water Resources Policy Issues (1955); (5) Presidential Advisory Comm. on Water Resources Policy (1955). The article examines the objectives and responsibility of the Federal government as well as repayment procedures in flood management, irrigation, hydroelectric power and municipal and industrial water supply. The reports are examined in each of the areas and present practices are compared with the policy recommended by the study groups. The policy issues in each area are pointed out as well as differences among the study groups.
W68-00446

TREUTING V BRIDGE AND PARK (RIGHTS AND LIMITATIONS OF A STATE GOVERNMENT TO SELL SUBMERGED LAND).
199 So 2d 627 (Miss 1967).

Descriptors: Multiple purpose projects, Navigation, *Ownership of beds, *Mississippi, State governments, Local governments, Project purposes, Recreation demand, Scenic easements, Stream improvement, *Tidal waters, High water mark, *Navigable waters, City planning.
Identifiers: Public trust doctrine.

The issue was whether the state may alienate in fee simple submerged lands. The court held that the legislation authorizing the sale did not violate the Mississippi Constitution provision that the legislature could not authorize permanent obstruction of navigable waters because the project would not interfere with navigation but improve it. Moreover, the provision is directed toward free navigation--not sale of submerged lands. The state owns all land under tidal navigable water in trust for the people of the state for the purposes of navigation, fishing, bathing and similar uses. However, the state may dispose of such submerged lands to the extent that such disposition will not interfere with the public's enjoyment of the uses for which the trust exists. Persons acquiring title to such lands from the state may not interfere with the common-law riparian rights of the upland owners. There is a private trust associated with submerged lands in favor of the upland owners whose lands border on the high water mark. Scale of submerged lands to private individuals for development and fill was permissible here, where the private purpose was incident to an overall public purpose.
W68-00447

FIFTY YEARS OF WATER LAW.
Harvard Univ., Cambridge, Mass.

Harv L Rev, Vol 50, No 2, pp 252-304, Dec 1936. 53 p, 2 fig, 136 ref.

Descriptors: Remedies, Beneficial use, *Competing uses, *Reasonable use, Water utilization, Prior appropriation, Riparian rights, Water rights, Civil law, Legal aspects, *Water law, Water allocation (Policy), Governments, Judicial decisions, Interstate, Political aspects, Water policy, Preferences (Water rights), Priorities, Water control.
Identifiers: Interstate conflicts.

An exhaustive survey of water law over the period 1887-1936 is presented. Emphasis is placed upon California decisions which reflect the conflicts and problems experienced in virtually every state. The conflict between upper-level riparian owners and lower-level owners has been the primary source of litigation over water rights. Such conflicts need not be private. Waters which have their source in one state commonly flow into numerous others, and the same conflict exists between upper-level and lower-level states. This results in a conflict as to whether prior appropriation or the riparian doctrine should control in water disputes. The tendency over the fifty year period was to adopt reasonable use of one's land as the sole test. Equality in place of physical position or priority becomes the determining factor. The reasonable use test demands consideration of all circumstances surrounding a water dispute. A salient feature of the period has been to compensate lower owners when upper owners exceed their reasonable use. The goals of prior appropriation are thereby realized, while lower owners are compensated for losses.
W68-00453

MISSISSIPPI WATER CONSERVATION LAW,
Mississippi Univ., Oxford.
Douglas C. Wynn.
Miss L J, Vol 28, No 3, pp 190-230, May 1957. 41 p, 351 ref.

Descriptors: Beneficial use, Competing uses, Reasonable use, *Water conservation, Water utilization efficiency, Administration, Desert Land Act, State governments, *Mississippi, Water allocation (Policy), Water distribution (Applied), *Water policy, Legal aspects, Legislation, Prior appropriation, Riparian rights, Water law, Judicial decisions.
Identifiers: Constitutional law.

The riparian doctrine and prior appropriation doctrine are discussed. It is concluded that the riparian doctrine is eminently more just because it does not allow for exhaustion of a stream under a priority which relates only to the time of the first diversion. Mississippi had limited the riparian doctrine and modified it greatly. The Mississippi water conservation law is discussed in detail. It is concluded that the act is an unconstitutional attempt to abolish vested property rights of riparian proprietors without compensation. The statute is lauded in its provisions setting up board of water commissioners and in its method for establishing appropriative rights. Its defects, aside from possible unconstitutionality, are that it does not set up a system of priorities and that it attempts no correlation between the law of watercourses, diffused surface water and groundwater.
W68-00454

STATE V BRENNAN (STATE REGULATION OF PUBLIC RIGHTS ON NAVIGABLE RIVERS).

216 A 2d 294-297 (Cir Ct Conn 1965).

Descriptors: *Connecticut, *Public lands, Navigable waters, Riparian land, Riparian rights, Local governments, State governments, State jurisdiction, Zoning, Legislation, *Hunting, Fishing, Boating, Water law, Legal aspects.

The defendant in the criminal case was found guilty of violating a town ordinance prohibiting the discharge of firearms within 500 feet of any building. The defendant was hunting on a navigable river adjacent to the town and was 280 feet from the nearest building. A state statute allowed hunting up to within 280 feet of any building. The town derived its power to prohibit hunting within town limits from a state enactment. The sole question presented was whether the river was within the town limits thereby making the ordinance applicable to it. The Court held that the state owned the river as representative of the public and the public has the right to boat, hunt and fish on the navigable waters of the state, subject only to the paramount right of navigation and to the privileges of riparian owners. The state preempted the field of regulating and encouraging the hunting of wildlife on public and private lands and waters. There was nothing in the state act that extended the authority of the town over navigable waters adjacent to it and the town must yield to the state statutes governing hunting on the river.
W68-00455

MELLON V STREET (INTERFERENCE WITH FLOW OF WATER ACROSS PROPERTY BOUNDARIES).
259 NYS 2d 900-902 (Sup Ct 1965).

Descriptors: *Easement, Water supply, Artificial watercourses, Real property, Water law, Legal aspects.

The plaintiff wanted to enjoin the defendant from interfering with the flow of water across the defendant's land to the plaintiff's land. The defendant's deed contained a clause saying that the conveyance was subject to the rights of the grantor to take water from the spring on the defendant's land and to lay and maintain a water pipe for that purpose. The Court enjoined the defendant on the basis of the language in his deed.
W68-00456

WOOD V SOUTH RIVER DRAINAGE DISTRICT (ALTERED RIPARIAN RIGHTS TO ARTIFICIAL WATERCOURSES).
422 SW 2d 33-39 (Mo 1967).

Descriptors: *Missouri, *Riparian land, Bodies of water, Natural streams, *Artificial watercourses, Riparian rights, Riparian waters, Drainage districts, Drainage systems, Legal aspects, Judicial decisions, Eminent domain, Compensation, Pumping, Water levels.

When a natural body of water is incorporated into a drainage system under a plan of reclamation by a drainage district, and when it is changed as a result of the implementation of the plans of the system, it ceases to be a natural body of water. A person who subsequently purchases land adjacent to this altered body of water has no riparian rights in the water because it is no longer a natural body of water. Thus, he has no right to the maintenance of the water in its natural state, and when the level of the water is subsequenctly reduced by pumping on the part of the drainage district, this is not a taking of property for which compensation must be paid. Lowering of the water level was pursuant to statutory authority granted to the drainage district under the laws of Missouri, in the public interest, and a valid exercise of the police power, for which no compensation need be paid.
W68-00457

LEGISLATION FOR WATER RESOURCES DEVELOPMENT,
Ministry of Works, New Zealand.
D. G. McGill.
Soil and Water, Vol 4, No 3, pp 9-10, Mar 1968. 2 p.

Descriptors: *Legislation, *Administration, Governments, Legal aspects, *Permits, Planning, Water rights, Public rights, *Water law, Federal Government, Jurisdiction, Water pollution, Riparian rights, Water allocation (Policy), Domestic water, Stock water.
Identifiers: *New Zealand, Water and Soil Conservation Act.

In 1967 the New Zealand Parliament passed the Water and Soil Conservation Act which came into operation Apr 1, 1968 and brings water resources development under the guidance of a central authority. Except for domestic, stock, and firefighting use, the sole right to take natural waters is vested in the Crown. The Act constitutes Regional Water Boards which have the power to grant water permits. The National Water Authority, the Soil Conservation and Rivers Control Council, the Pollution Advisory Council, and the Water Allocation Council are grouped together to form the National Water Organization. The Authority is empowered, subject to its continued overriding responsibility, to apportion between itself and the 3 councils all its functions.
W68-00521

WATER RESOURCES AND THE LAW.

Includes W68-00582 through W68-00604. Michigan Univ. Law School, Ann Arbor, 1958, pp 1-614. 1 tab, 4 chart, 1953 ref, append.

Descriptors: *Water law, Hydrologic aspects, Water policy, Legislation, *Water resources, Water conservation, *Riparian rights, *Interstate compacts, Water rights, Water permits, Watercourses (Legal), Judicial decisions, Public rights, Bodies of water, Water pollution.
Identifiers: *Model Water Use Act, *Police power, Constitutional law.

This volume combines the written contributions prepared for the Tenth Annual Summer Institute of the University of Michigan Law School on 'Water Resources and the Law' and the monographs and Model Water Use Act prepared by staff of the university's Legislative Research Center. A wide range of subject matter representative of the views of both the engineering and legal professions is covered. The interrelationship between hydrology and the law is examined. Overviews of legal problems arising from changing needs, uses, and availability of water, and the means by which the law can meet these difficulties, are presented. Both common law doctrines of water use and statutory regulation of water resources are surveyed. The concept of the riparian right as property is thoroughly analyzed, followed by a study of the regulation of water rights under the police power. Interstate compact control of water resources, a device which may be more frequently utilized in the future, is reviewed. Present Michigan water law is examined in depth, and the Model Water Use Act is set forth.
W68-00581

WATER AND THE LAW,
Clarence A. Davis.
In Water Resources and the Law, pp 39-48, 1958. Michigan Univ. Law School, Ann Arbor, 10 p, 2 ref (see W68-00581).

Descriptors: Competing uses, Water requirements, Water storage, Long-term planning, *Water law, *Water policy, Water rights, *Water resources, Weather modification, Desalination, Federal-state water rights conflicts, Water reuse.

Broad over-all aspects of problems facing water resources and the law are examined with the thought that an era is approaching in which many of our concepts regarding the law of waters will of necessity be revised. Many questions are posed regarding legal problems in the field of water resources, and the importance of power of water control is emphasized. Solution to water resource problems will require much further research and the courage to act upon the facts research discloses. The article asserts that only economic necessity will gain the consent of the people to regulatory water resources legislation. The most fundamental legal problem in the field of water resources is thought to be the delineation of federal and local activity and the determination of federal constitutional power. The article concludes that scarcity creates all water problems. Three possibilities for alleviating scarcity are reuse, demineralization of brackish and salt water, and weather modification.
W68-00584

RIPARIAN RIGHT AS PROPERTY--CONSTITUTIONAL SAFEGUARDS OF PROPERTY,
Theodore E. Lauer.
In Water Resources and the Law, pp 137-149, 1958. Michigan Univ. Law School, Ann Arbor, 13 p, 22 ref (see W68-00581).

Descriptors: Legislation, Water law, Legal aspects, *Riparian rights, Eminent domain.
Identifiers: *Constitutional law, *Property rights, Private property, *Fifth Amendment.

The constitutional safeguards of property which must not be abridged by any legislation modifying the riparian doctrine are set forth. The Fifth and Fourteenth Amendments of the United States Constitution together prohibit the federal or state governments from depriving any person of property 'without due process of law; nor shall private property be taken for public use, without just compensation.' The optimum water legislation must be a measure which will not result in a taking of private property without due process. An analysis of the constitutional safeguards must take into account two principal elements: (1) the existence of a relationship between a person and an object which amounts in legal significance to property; and (2) a governmental act which results in a taking thereof without due process. If either element is absent, the constitutional provisions have not been infringed. Each of these elements is examined, concluding that the principles laid down by the courts do not suffice to distinguish between property and non-

property, or between a taking which violates due process and a valid exercise of the police power or the fundamental lawmaking power.
W68-00588

THE RIPARIAN RIGHT AS PROPERTY--RECOGNIZED LIMITATIONS UPON THE RIPARIAN RIGHT,
Theodore E.Lauer.
In Water Resources and the Law, pp 211-255, 1958. Michigan Univ. Law School, Ann Arbor, 45 p, 109 ref (see W68-00581).

Descriptors: Eminent domain, Judicial decisions, Legislation, *Federal government, *State governments, Ownership of beds, *Public rights, Riparian rights, *Water law, Watercourses (Legal), Navigation, Navigable waters, Fishing, Proprietary power, Treaties, Interstate compacts, Riparian waters, Hunting, Riparian land.
Identifiers: *State trust doctrine, Interstate apportionment, *Public interest, Constitutional law.

The interest of the riparian owner in the waters of the streams adjacent to his lands is not absolute, but subject to a number of acknowledged limitations in favor of both individual members of the public and the state as representative of the public interest. This section is concerned both with a brief enumeration of these limitations and with the power to add new restrictions. Limitations in respect to members of the public include navigation, fishing, and in some cases, hunting. Limitations, in respect to the state and federal governments include the governmental proprietary power, based on title to the bed of a watercourse, its banks, or the water itself, control through the 'general welfare' clause, the power to make treaties and interstate compacts, the power of the federal government to make interstate apportionments, and the power to acquire private property through eminent domain. Each of these limitations is carefully analyzed, concluding that together they indicate the law's recognition of the overriding public interest in watercourses. The author suggests that the treaty and compact-making powers should not be used directly to limit riparian rights.
W68-00591

REGULATION OF WATER RIGHTS UNDER THE POLICE POWER--SECTIONS I-IV,
Dominic B. King.
In Water Resources and the Law, pp 269-290, 1958. Michigan Univ. Law School, Ann Arbor, 22 p, 133 ref (see W68-00581).

Descriptors: Riparian rights, *Legisation, Eminent domain, Oil wells, Condemnation, *Water rights, Public benefits, Natural gas, Legal aspects, *Regulation.
Identifiers: Constitutional law, *Police power, General welfare, Private property.

The article's purpose is to determine whether legislation modifying, limiting, or abridging riparian rights amounts to a taking of property for which compensation must be paid; or, whether it is a regulatory measure within the proper scope of the state police power so as to preclude the necessity of compensation. An effort is made to discern rational guides of proper constitutional delineation in the management, control, and conservation of water resources. The general background of the police power is first examined. This power is described as a convenient summation of the power inherent in the sovereignty to perform adequately all the requisite functions of a civilized government in the promotion of the general welfare. The power is primarily exercised by the states, subject to the limitations of state and federal constitutions. Today it is almost a truism that all property is held subject to reasonable state regulation under the police power. Areas in which the police power has found application are set forth, and problems arising from regulation of oil and gas resources--the area most nearly analogous to ground water resources--are examined.
W68-00594

REGULATION OF WATER RIGHTS UNDER POLICE POWER--SECTIONS V-VI,
Dominic B. King.
In Water Resources and the Law, pp 290-308, 1958. Michigan Univ. Law School, Ann Arbor, 19 p, 77 ref (see W68-00581).

Descriptors: Riparian rights, Legislation, *Water rights, *Regulation, Public benefits, Legal aspects, Beneficial use, Administrative agencies, Water resources, State governments, *Judicial decisions, Oregon, Kansas.
Identifiers: Constitutional law, *Police power, General welfare, Public interests, Economic interests.

Regulatory water statutes in general are discussed, with specific attention given to statutes abridging the riparian right to future use and establishing of a state agency with comprehensive power to administer water use under the standard of beneficial use to the society. Each state is free to establish any system of water rights it desires, and is also free, according to dictum in United States Supreme Court decisions, to change the system after it is established. Supreme Court decisions also indicate that in the regulation of water there is always supplied the element of an important public interest, a requisite for exercise of the police power. After examining Supreme Court decisions and selected state cases dealing with legislation affecting future use under the riparian system, it is concluded that the state may impinge upon riparian rights to future use without destroying a present, vested property interest. Supreme Court decisions concerning state regulation of economic interests indicate that it is currently inconceivable that the Court would invalidate a statute regulating the use of water and limiting the riparian right to water actually being beneficially used.
W68-00595

REGULATION OF WATER RIGHTS UNDER THE POLICE POWER--SECTIONS VII-IX,
Dominic B. King.
In Water Resources and the Law, pp 309-352, 1958. Michigan Univ. Law School, Ann Arbor, 44 p, 1 tab, 173 ref (see W68-00581).

Descriptors: Florida, Indiana, Pennsylvania, Wisconsin, *Judicial decisions, *State governments, Beneficial use, Administrative agencies, *Regulation, Prior appropriation, Water resources, *Water rights.
Identifiers: *Police power, Constitutional law, Model Water Use Act.

It is possible for regulatory legislation, which would be upheld by the United States Supreme Court, to be declared violative of a state constitution's due process clause by a state supreme court. Thus the issue involved is whether state courts will uphold a police power enactment which alters the common law riparian to future use of water and which allows a state agency extensive regulation over water use pursuant to the criterion of beneficial use. With the exception of Minnesota, where such legislation would probably be sustained, only decisions in western states are analyzed in this regard. In order to appraise eastern judicial tolerance for extensive water regulation, court decisions in Florida, Indiana, Pennsylvania and Wisconsin-states representing the most conservative approach in dealing with police power, economic regulation and substantive due process-are examined. It is asserted that extensive regulation would be upheld in all eastern states, with Pennsylvania remaining somewhat doubtful. It is concluded that only exercises of legislative power so patently arbitrary that they could commend themselves to no rational man ought to be invalidated by the courts in the area of property regulation.
W68-00596

PUBLIC RIGHTS IN MAINE WATERS,
U of Main School of Law, Portland.
G. Graham Waite.
Me L Rev, Vol 17, pp 161-204, 1965. 44 p, 237 ref.

Descriptors: *Maine, *Public rights, *Water law, *Water rights, Tidal waters, Remedies, Legislation, Judicial decisions, International law, Administrative agencies, Preferences (Water rights), Recreation, Watercourses (Legal), Lakes, Taxes, Federal government.
Identifiers: Great ponds, Colonial Ordinance of 1641-7, Public trust doctrine.

Public rights in water are controlled by state, federal and international law. The definition of 'public' in Maine law is not clear. Public rights of use exist in waters affected by tides, in great ponds, i.e., lakes whose surface area is at least ten acres, and in waterways that can be used for transportation of property. Particular public rights are examined as they may be exercised in the above water-bodies. Public rights stem from either the common law or the Colonial Ordinance of 1641-7. These rights are expressed in the public trust and the easement doctrines, each of which is discussed, along with the judicial remedies available for the protection of public rights. Public rights of access are examined. Legal problems in controlling and promoting water recreation involved the power to regulate and tax water use. State power to create and regulate public rights in Maine's waters is limited by overriding federal and international law. A summary is presented, and suggestions are made for government action to expand outdoor recreation.
W68-00617

BERGERON V FORGER (WATER CONTRACTS FOR WATER USE RIGHTS).
125 Vt 207, 214 A 2d 85-90 (1965).

Descriptors: *Vermont, Leases, Permits, Water rights, *Water contracts, Water transfer, Legal aspects, Judicial decisions.

Plaintiff claims a right to take water from defendant's spring by a deed or license, and seeks an injunction to prevent the defendants from interfering with the flow of water to his premises and damages for interference. The Vermont Supreme Court held that whether an instrument is a lease or license depends on the intent of the parties, and even if a contract purports to be a license, if it is strictly within the definition of a lease it will be declared a lease. The contract in question is a lease to take water from the defendant's aqueduct. The right to take water from a water system is an interest in real estate. Each acceptance of the annual rental by the defendants after the lease had expired extended the terms of the lease agreement for an additional year, and gave the plaintiff a legal right to take water from the system.
W68-00626

CENTRAL MAINE POWER CO V FEDERAL POWER COMM'N (REVIEW OF FEDERAL POWER COMM. LICENSING OF HYDROELECTRIC PROJECTS).
345 F 2d 875-878 (1st Cir 1965).

Descriptors: Federal Power Act, *Hydroelectric project licensing, Legal aspects, Administrative agencies, Federal jurisdiction, Navigable waters, Permits, Federal government, Judicial decisions, Legislation.
Identifiers: Federal Power Commission.

This is a petition to review an order of the Commission which required petitioner to take a license retroactively. The effect of the order was to shorten the maximum 50-year term to 24 years, to impose liability for fees retroactively, and to commence at an earlier date petitioner's obligation to amortize excess earnings. Petitioner failed to file a declaration of intention to build a hydroelectric plant with the Commission and constructed the plant without notifying the Commission. The court held that although the river upon which the plant was constructed had not at that time been judicially determined navigable, it may have been within the jurisdiction of Congress under its authority to regu-

late commerce because of possible effects on navigable waters. The Commission's determination that petitioner was unreasonable in not filing a declaration is supported by the facts, and under the circumstances it was neither discriminatory nor a true penalty for the Commission to treat petitioner in terms of its license as it would have treated it had it complied with the statute.
W68-00628

FAHNESTOCK V OFFICE OF GEN SERVS (JURISDICTION OF SUBMERGED LAND GRANTED FOR PUBLIC USE).

24 A D 2d 98; 263 N Y S 2d 811-812 (1965).

Descriptors: *New York, *Ownership of beds, Beds under water, State government, Local government, Judicial decisions, Cities.
Identifiers: *Public trust doctrine.

This was an action to prevent construction of a municipal incinerator plant on lands in Hempstead Harbor. By legislative act the Office of General Services was empowered to grant to the town title to lands under water in the harbor. Pursuant to this act letters patent were issued to the town for 52 acres of land under the harbor. The petitioner attacked the grant on the grounds that: (1) The grant was not for a public purpose; (2) The grant would violate the public trust; (3) The grant was too extensive. The court dismissed the petition, stating that a grant of land to a municipality is impliedly for a public purpose and such implication is a limitation on the municipality for other than such use. It was not shown that the lands would be put to such use as would violate the public trust.
W68-00635

THOMPSON V ENZ (RIGHT-OF-ACCESS TO LAKE WATERS FROM CANALS).

379 Mich 667, 154 N W 2d 473-487 (1967).

Descriptors: *Michigan, *Riparian land, Natural streams, Artificial watercourses, Riparian rights, Legal aspects, Judicial decisions, Watercourses (Legal), Easements, Artificial use, Natural use, Canals, Reasonable use, *Severance.
Identifier: *Right of access.

Plaintiffs seek to prevent the defendant landowners from subdividing their lakefront property, digging canals in such a manner that all property will front on either the lake or a canal which is connected to the lake, and granting riparian rights and right of access to all property owners who do not front on the lake but do front on a canal. The Supreme Court of Michigan held that a riparian owner was one whose property was in contact with a natural body of water. Land abutting on an artificial watercourse, such as a canal, carries no riparian rights, and riparian rights may not be granted, severed, or assigned to it from land which includes or is bounded by a natural watercourse. Interposition of fee title between the upland and the water destroys the upland's riparian rights. While riparian rights may not be conveyed or reserved, easements, licenses and the like for a right of access to a watercourse do exist and are often granted to non-riparian landowners. This right of access is an artificial use, and must be reasonable under all the circumstances.
W68-00637

THE IMPROVEMENT AND MODERNIZATION OF NEW YORK WATER LAW WITHIN THE FRAMEWORK OF THE RIPARIAN SYSTEM,
U of Wyoming College of Law, Laramie.
William H. Farnham.
Land and Water L Rev, Vol 3, No 2, pp 377-433, 1968. 57 p, 196 ref.

Descriptors: *New York, *Riparian rights, *Legislation, Water law, Prior appropriation, Judicial decisions, Riparian land, Domestic uses, Permits, Water utilization, State government, Natural flow doctrine, Reasonable use, Relative rights.
Identifiers: *Constitutional law, *Police power, N Y Conservation Law.

This article is a plea for legislative clarification of the riparian doctrine in N Y. New and proposed legislation within the framework of the riparian doctrine is reviewed. The constitutionality of this legislation is discussed, in terms of required compensation and the state police power. The status of many riparian rights in N Y has been uncertain, discouraging private enterprise and making governmental water projects more difficult. In 1966 the N Y legislature enacted a law which required a riparian plaintiff to show actual harm to him before he could enjoin a use by another riparian. This law changed the N Y rule from natural flow to reasonable use. The author suggests the following legislation to improve the riparian doctrine in N Y: (1) A definition of riparian land; (2) A definition of domestic use; (3) A provision for transfer of riparian rights apart from the land; (4) A permit system to accomodate the needs for certainty and flexibility in water rights; (5) Relaxation of restrictions on non-riparian uses. The prior appropriation is briefly examined. The author concludes that the riparian system, supplemented by the above suggested legislation, is best for N Y.
W68-00641

6F. Nonstructural Alternatives

MAP REQUIREMENTS FOR FLOOD-PLAIN STUDIES,
US Geological Survey.
B. Thomas Hopkins.
Civil Eng--ASCE, Vol 38, No 2, p 66-67, Feb 1968. 2 p, 3 fig.

Descriptors: *Flood plains, *Maps, Topography, Photogrammetry, Land use, Remote sensing, Contours, *Urbanization, Hydrologic aspects, Drainage systems, Flooding, Flood plain zoning, Streams, Surface waters, Photography.
Identifiers: *Orthophotomaps, Photoimagery, *Preventive hydrology, Flood hazard.

Fairfax County, Virginia was the site of a pilot study and related projects in preventive hydrology. The study is described as a unique effort to determine probable extent of flood hazards in an area of rapidly increasing urban development. Purposes of this program is to establish a procedure by which the extent of flooding on a network of stream basins can be predicted for 25-, 50-, and 100-yr flood recurrence intervals as the watershed areas are developed. Flood plains comprise 6% (200,000 sq mi) of the area in the 48 conterminous United States. Maps are essential for flood-plain studies to assist in greatest utilization of land without excessive flood damage. To support these studies the U. S. Geological Survey is mapping certain pilot areas, in cooperation with local agencies. Maps of 1:1,200 scale and 2-ft contours are compiled from photography at flight height of 3,000 ft. Flood boundaries determined for various recurrence intervals are delineated on the maps. Orthophotomaps, retaining photoimagery details, with reference grids and superimposed contours offer additional benefits in flood-plain studies.
W68-00331

FLOOD CONTROL ALTERNATIVES AND FLOOD INSURANCE,
Rutgers University, Water Resources Research Institute, New Brunswick, NJ.
William Whipple, Jr.
Civil Eng--ASCE, Vol 38, No 2, pp 68-69, Feb 1968. 2 p, 3 ref.

Descriptors: *Flood plain insurance, Flooding, *Flood control, Flood plain zoning, Levees, Channel improvement, Dams, *Non-structural alternatives, Floodways, Abatement, Reservoirs, Disasters, Land management, Watershed management, Administration, Land use, Overflow, Legislation, Damages.
Identifiers: *National insurance plan, Premiums (Insurance), Hazard areas, Flood control plans, Flood events, Alternative plans.

Proposals for a national scheme of flood-plain insurance are discussed; administrative costs, cited; and alternatives, suggested for a system of floodways that can be incorporated into every major flood control plan. Although attempts to obtain Congressional authorization of an insurance program at Federal expense has a certain plausibility, the arguments for it need critical professional analysis before the U.S. becomes committed to an unworkable, inequitable, and expensive program. Flood area encroachment grows at an increasing pace where protection is provided. Legislation under consideration in Congress would require an enlarged bureaucracy and would fail to remedy uncontrolled flood-plain developments despite large and unfairly distributed costs. Reasonable alternatives are: (1) A levee system that automatically delineates between protected and unprotected areas, and (2) a flood-way system, preserved against future development. These can be a part of every major flood control plan act of Congress; they would eliminate much cost in administration and subsidy.
W68-00350

ACQUISITION AND PROTECTION OF WATER SUPPLIES BY MUNICIPALITIES,
Michigan Univ., Ann Arbor.
Wilbert L. Ziegler.
Mich L Rev, Vol 57, No 3, pp 349-388, Jan 1959. 30 p, 166 ref.

Descriptors: Cities, City planning, Governments, *Local governments, Regional analysis, State governments, Water districts, Water law, Water resources, *Water resources development, Equitable apportionment, Public benefits, Public rights, Conservation, *Municipal water, Judicial decisions, Legislation, Legal aspects, Project planning.

The acquisition and protection of adequate municipal water supplies is discussed. Municipalities must be concerned with the protection of particular parcels of land for future condemnation and with conservation of lands located in the general area of chosen sites. The most common municipal power is to deny building permits for construction in areas marked for future public use. A more effective power would be to allow municipalities to provide for compensation to the owner for reservation of his land. With expansion, these powers could prove invaluable to a municipality trying to protect future water supplies. It is not yet settled in most states whether or not zoning can be used to conserve natural resources. It is concluded that municipalities have, or can get through legislative grants sufficient power to protect and reserve water source areas. As demand approaches supply, however, state action becomes more important if an equitable apportionment of the state's waters is to be attained.
W68-00424

FLORIDA AIR AND WATER POLLUTION CONTROL ACT.
FLA STAT 403.011-403.261 (1967).

Descriptors: Air pollution, Industrial wastes, *Water pollution, *Water pollution control, Water quality control, Standards, Administrative agencies, Administration, *Florida, *Water law, *Water policy, Water permits, *Legislation, Water rights, Beneficial use, Taxes, Pollutants, Adjudication procedure, Administrative decisions, Water quality.
Identifiers: *Florida Pollution Control Act, Pollution control commission, Public policy, Sanctions.

A legislative declaration of the public policy underlying the statute is first set forth. It is declared, inter

alia, that the public policy of the state is that no wastes be discharged into any waters of the state without the first being given treatment necessary to protect the beneficial use of such water. The more significant provisions of the statute include the establishment of the Florida Air and Water Pollution Control Commission. Powers and duties of the commission are established, which include adoption of a comprehensive program for prevention, control, and abatement of pollution, classifying waters of the state according to their most beneficial use, establishment of air and water quality standards, establishment of a permit system, and rule-making powers. Enforcement provisions and procedures, which include civil and criminal sanctions, are included. Judicial review of commission actions is allowed, and rules for local pollution control programs are presented. The statute provides that the commission may grant a variance from provisions of the statute for enumerated reasons. Pollution control devices are classified for tax purposes and are given tax benefits.
W68-00429

WATER PROBLEMS IN THE SPRINGFIELD-HOLYOKE AREA, MASSACHUSETTS-A LAYMAN'S LOOK AT WATER IN A METROPOLITAN AREA (CHAPTERS 1-3),
US Geological Survey.
J. C. Kammerer, and H. L. Baldwin.
Geological Survey Water-Supply Paper 1670, pp 6-29, 1963. 24 p, 6 fig, 10 photo, 1 dwg, 1 tab.

Descriptors: *Massachusetts, New England, Geology, *Floods, *Flood protection, Levees, Flood damage, Flood plain zoning, *Interstate compacts, Historic flood, Reservoirs, Reservoir storage, Reservoir sights, *Groundwater, Rock properties, Rivers, Flood control, Administrative agencies.
Identifiers: *Connecticut River, Geography, Flood Control Act of 1936, Flood stage, Flood walls.

The area has a water management problem. Vermont, New Hampshire, Massachusetts, and Connecticut are affected. Several federal agencies are involved. The 313 square mile area draws upon the runoff of 9,000 square miles. The Connecticut, Westfield, and Chicopee Rivers supply adequate quantities of water except during severe drought periods. Dams and reservoirs are used for conservation storage, municipal supply, the manufacture of water power, recreational purposes and flood-control. Groundwater from wells, as affected by the three major groups of rocks in the area, is another source of water. $19,635,000 is the estimated annual loss from flooding, with major floods occurring in 1927, 1936, 1938, 1948, and 1955. Flood plain zoning is being considered. Levees and flood walls are utilized for local flood protection. Several industrial plants privately construct flood-control works. The Flood Control Act of 1936 authorized construction of reservoirs. Interstate flood-control compacts are involved. A conflict exists between the upstream landowner who suffers when a reservoir is built, and those downstream who suffer when it isn't. 11 out of 27 reservoirs have been built.
W68-00451

INTERSTATE WATER COMPACTS--SECTIONS I-IV,
Dominic B. King.
In Water Resources and the Law, pp 353-375, 1958. Michigan Univ. Law School, Ann Arbor, 22 p, 88 ref (see W68-00581).

Descriptors: *Interstate compacts, Water resources development, Water law, State governments, Federal government, Legislation, *Judicial decisions, Jurisdiction, Riparian rights, Water rights, Watercourses (Legal), Legal aspects.
Identifiers: *Constitutional law, Property rights.

Maximum water development on a regional level requires interstate cooperation; and foremost among the means available to states for such cooperation is the interstate compact. The article first examines the nature of interstate compacts under the federal constitution, finding congressional approval necessary for compacts affecting interstate waters. The constitutional reservoir of congressional power remains unchanged by consent to a compact. There are no legal guidelines for the state action in the formation of compacts, although joint commissions are generally utilized. Interstate compacts, once completed, are clearly binding upon signatory states and their citizens. However, there is some difficulty in formulating the rationale for this result, as well as the means for enforcing it. The most recent U. S. Supreme Court decision on the status of compacts held that although a compact was not national law, the construction of a compact involves a federal question to be decided by federal courts. Supreme Court jurisdiction over compacts is reviewed. Although a state cannot enter into a compact which violates either state or federal constitutions, the U. S. Supreme Court, not the state courts, has the final voice on the matter.
W68-00597

INTERSTATE WATER COMPACTS--SECTION V,
Dominic B. King.
In Water Resources and the Law, pp 375-391, 1958. Michigan Univ. Law School, Ann Arbor, 17 p, 61 ref (see W68-00581).

Descriptors: *Interstate compacts, *Judicial decisions, *Legislation, State governments, Interstate rivers, Equitable apportionment, Water allocation (Policy), Administrative agencies, Federal government, Water law, *Water policy, Interstate rivers.
Identifiers: Enforcement, Constitutional law.

Methods of solving interstate water problems, exclusive of the compact, are analyzed. They are divided into the catagories of constitutional and extraconstitutional methods, the latter including: (1) uniform state laws; (2) uniform state legislation; (3) uniform and harmonious state court decisions; (4) governor's conferences; (5) federal grants in aid to stimulate local action; (6) fusion of administrative agencies through cooperative joint sessions to deal with the legally separate parts of a single common interests. It is asserted that in the field of interstate water planning and administration it is clear that none of these methods is adequate to meet problems which require legally enforceable rights and duties. Of the three constitutional methods, the first, interstate compacts, has been previously discussed. The second, interstate litigation before the Supreme Court, is examined and found to be neither final nor satisfactory. The third method, congressional legislation, while necessary to water resources development, should permit the primary responsibility and control over such development to remain with the states. Reasons for this conclusion are set forth and analyzed.
W68-00598

INTERSTATE WATER COMPACTS--SECTIONS VI-VII,
Dominic B. King.
In Water Resources and the Law, pp 391-422, 1958. Michigan Univ. Law School, Ann Arbor, 32 p, 4 chart, 59 ref (see W68-00581).

Descriptors: *Administration, Administrative agencies, State governments, Federal government, Interstate commissions, Water law, Water policy, *Interstate compacts, Political aspects, Legal aspects, *Negotiations.
Identifiers: *Enforcement.

The compact device is far from a perfect means for water resources regulation. There are four major criticisms of interstate compacts which have become significant in judging the feasibility or desirability of using the compact method to settle interstate water problems. First, there is the problem of negotiating the compact; second, there is the difficulty of adequate enforcement powers; third, there is the matter of compact inflexability; and fourth, there is the lack of adequate regulatory and administrative powers. Each of these criticisms is examined. For example, the average length of time for negotiating and concluding eighteen of the existing twenty-one compacts was 11.9 years. Only eight of the existing twenty-one compacts meet the standards the author sets forth to determine whether a compact contains adequate enforcement powers. However, it is concluded that only the deficiency of the time required to negotiate the agreement is inherent in the compact device, and that on the whole interstate water compacts have performed better than other available devices. Recommendations are made for concluding compacts and suggested compact provisions are set forth.
W68-00599

BOARD OF ED OF UNION FREE SCH DIST NO 11 V N Y QUIST (ISLAND BOUNDARY CHANGE BY ACCRETION).

28 A D 2d, 281 N Y S 2d 486-490 (1967).

Descriptors: *Accretion (Legal aspects), Avulsion, *Boundaries (Property), Deposition (Sediments), High water mark, *Islands (Metes and bounds), New York, Judicial decision.

The mean high water mark of Anderson Island bordering on a tidewater channel was established in 1927 as a portion of the northern boundary of a school district. The district superintendent redefined the boundary line, making part of Anderson Island fall into the northern district. The Acting Commissioner of Education set aside the order on the grounds that the part of the island, affected by the redetermination of the boundary, had been formed by accretion and accordingly became part of the southern district. The Supreme Court, Appellate Division agreed with the reasoning of the Acting Commissioner. The court noted that some governmental boundaries were not fixed but are variable, such as the ones running along tidal waters. These boundaries are affected by the rules of avulsion, erosion, and accretion. When land bordering a body of water is increased by accretions, the new land thus formed belongs to the owner of the upland to which it attaches.
W68-00611

U S V 2,134.46 ACRES (OWNERSHIP OF LAND ACCRETION TO OPPOSITE RIVER BANKS).
257 F Supp 723-28 (DCND 1966).

Descriptors: *Riparian land, Riparian rights, Banks, *Accretion (Legal aspects), Boundaries (Property), Real property, Condemnation, Navigable waters, Non navigable waters, Legislation, *North Dakota, Erosion, Islands, Meander.
Identifiers: Non-riparian land.

The question in the condemnation proceeding involved the ownership of accreted lands on the bank of the Missouri River. An island in the river at the time of the original survey subsequently eorded and washed completely away. Later, the accretion in question was formed on the east bank of the river. The court held that where a water line is the boundary of a given lot, that line, no matter how it shifts remains the boundary. The court applied Section 47-06-05, N D C C in holding that land formed from natural causes by imperceptible degrees on the bank either by accumulation of material or by the recession of the stream belongs to the owner of the bank. The statute does not apply, however, when the land forming the bank was not riparian land at the time of the original survey, such as the case when a bank is eroded back to a point where a non-riparian land owner becomes a riparian landowner and then the accretions are added.
W68-00619

CIVIL LAW PROPERTY - ALLUVION - DISTINGUISHING LAKES FROM RIVERS AND STREAMS,
Louisiana Law Review, Baton Rouge.
Kenneth E. Gordon.

La L Rev, Vol 25, No 2, pp 554-558, Feb 1965. 5 pp, 19 ref.

Descriptors: *Louisiana, River, Stream, *Lake, *Accretion, Bodies of water, River flow, Stream erosion, Silts, Alluvium.

Article 509 of the Louisiana Civil Code, referring to accretions, applies only to rivers and streams, not to lakes. The crucial question has been whether a particular body of water is to be classified as a lake, or as a river or stream, and what test should be employed to make the classification. Early cases held that a body of water is a river or stream if the water moves, even though it does not flow constantly, and if it has the power to carry silt and form alluvion. This test created a practical problem in its application and has proved to be too vague. In addition to considering the old test, a recent case also considered other geological characteristics presented by experts as being typical of streams as opposed to lakes such as: (1) lack of peat moss; (2) lack of wave action; (3) V-shaped basin; (4) sinuous bank line; and (5) winding course. This test simplifies the characterizing of a body of water as a river or stream and its judicial adoption is advocated by the author.
W68-00622

ROCHESTER GAS AND ELECTRIC CORP V FEDERAL POWER COMM'N (LICENSING OF HYDROELECTRIC PLANTS ON NAVIGABLE WATERS).
344 F 2d 594-599 (2d Cir 1965).

Descriptors: Federal Power Act, *Hydroelectric project licensing, Legal aspects, Navigable waters, Navigation, Rivers and Harbors Act, Judicial decisions, Legislation, Administrative agencies, Federal jurisdiction, Federal government, Permits.
Identifiers: Federal Power Commission.

Petitioner requested the Commission to issue an order declaring that its four electric power projects did not have to be licensed under Section 23 (b) of the Federal Power Act, 16 U S C 817. The Commission rejected the request, directed the petitioner to apply for licenses, and petitioner appeals. The court held that if the projects are on navigable waters they must be licensed, and that decisions under the Rivers and Harbors Act as to navigability are applicable. A river is navigable if it presently is being used or is suitable for use, or it had been used or was suitable for use in the past, or it could be made suitable for use in the future by reasonable improvements. The Commission's findings as to navigability are those of fact, and are conclusive if supported by substantial evidence.
W68-00623

STATE V HOOPER (JURISDICTION OF SHELLFISHING RIGHTS ON STATE-OWNED, SUBSURFACE LANDS).

209 A 2d 539-545 (Conn Ct App 1965).

Descriptors: Ownership of beds, Local governments, State governments, Littoral, Prescriptive rights, Public rights, *Connecticut, State jurisdiction, Navigation, *Leases, Judicial decisions.
Identifiers: *Public trust doctrine.

Defendant was charged with violation of a Connecticut statute in towing a dredge over a designated oyster bed for the purpose of gathering oysters, without the permission of the owner or lessee who traced his rights to the state. The court held that neither the state nor towns, as subdivisions of the state, acting under statutory powers in designating oyster beds for cultivation and exploitation by private persons, can confer a title in fee to lands lying under the sea over which the state has dominion. In Connecticut the lands underlying Long Island Sound and Fisher's Island Sound, from below the high water mark to the line dividing Connecticut and New York is owned by the state in trust for the public. This title is subject only to the public right of navigation. However it may be affected by lawfully acquired privileges and franchises of littoral proprietors or others such as shellfishermen, who by statutorily authorized lease or perpetual franchise may acquire the exclusive right to plant, cultivate and harvest shellfish on designated grounds.
W68-00624

NANCE V TOWN OF OYSTER BAY (BOUNDARY DEMARCATION FOR HARBOR DREDGING).

23 A D 2d 9, 258 N Y S 2d 156-170 (Sup Ct 1965).

Descriptors: *New York, *Ownership of beds, Beds under water, Legal aspects, Boundaries (Property), Boundary disputes, Damages, Dredging, Judicial decisions.

A taxpayer of Oyster Bay, New York brought this action to enjoin dredging operations and removal of underwater land in the adjacent harbor by Huntington, New York, a town directly across the harbor from Oyster Bay. He also sought damages on behalf of Oyster Bay for the wrongful removal of their underwater land by the defendants. The Appellate Division of the Supreme Court held that both towns owned underwater lands by virtue of patents issued to them by prior governors. After establishing the boundary line the court held that the plaintiff could recover damages for the wrongful removal of land on their side of the line.
W68-00625

RICE V NAIMISH (LEGAL RIGHT-OF-ACCESS TO LAKE WATERS BY RIPARIAN LANDOWNER).
8 Mich App 698, 155 N W 2d 370-376 (1967).

Descriptors: *Michigan, *Riparian land, Riparian rights, Legal aspects, Judicial decisions, *Severance, Reasonable use, Water levels, Ownership of beds, Lakes, Fluctuation, Boundaries (Property), Beds under water, Access routes.
Identifiers: Right of access.

A riparian owner has the right to use his upland property to gain access to lake waters, and the right to use the entire surface and subsurface waters of the lake. Each riparian owner shares such rights with all other riparian owners, and none may unreasonably interfere with the rights of the others. In a non-navigable lake the owner of the uplands holds title to the submerged extension thereof to the center of the lake bed. If a riparian owner builds a fence on his submerged lands so as to interfere with another riparian owner's right of access, the latter is privileged to prevent construction of the fence or to demolish it at any time without first obtaining permission of a court. In order for property to have riparian rights it must touch the water, but this touching need not be constant. If water touches the property when the water is at its usual or normal level, the property is riparian. A temporary drop in the level of the water so that the property no longer touches the water is not sufficient to divest the property of its riparian nature.
W68-00632

WEISENBURGER V KIRKWOOD (BOUNDARY REDETERMINATION FROM A RECEDING LAKE FRONT).

7 Mich App 283, 151 N W 2d 889-894 (1967).

Descriptors: *Michigan, *Boundaries (Property), Ownership of beds, Shores, Erosion, Legal aspects, Judicial decisions.

When a lake has a receding shoreline owners of inland lake front property are entitled to the just proportion of the land between the old and new shorelines, under Michigan law. Regardless of the method used to divide a lake bed, the common theory of all is that the shore owners take ratably. Use of the center line of the lake to apportion lake beds is permitted when it is known but use of an unknown center line is not proper, and in such cases where the center line is unknown a proportional allocation of the new shore line is proper.
W68-00634

O'NEILL V STATE HIGHWAY DEP'T (BOUNDARY DETERMINATION IN TIDELAND WATERS).
50 N J 307, 235 A 2d 1-12 (1967).

Descriptors: *New Jersey, Judicial decisions, Legal aspects, Boundaries (Property), Boundary disputes, High water mark, *Tidal marshes, Tidal waters, Elevation, Ownership of beds.

This case involves the ownership of lands along a river claimed by the State of New Jersey to be tidelands, and as such to be its property. The state owns in fee simple all lands that are flowed by the tide up to the high water line or mark, which is a mean of all high tides over a period of years. If the elevation of the mean tide is known, the tidal boundary may be established by elevations taken on the land. In that case, evidence that land above that elevation is periodically covered by high tide would not prove that it is tideland. All land below that elevation is not necessarily tideland, as it must in fact be tide-flowed. Thus, interior land which is below that elevation and which the mean high tide does not reach naturally is not tideland. Use of artificial means to increase or decrease the amount of tide-flowed land does not alter its original status, and the burden of proof is on the party who challenges the presently-existing scene to show that the tideland status was changed by such artificial means.
W68-00638

TIDELAND OWNERSHIP,
Wayne H. Dawson.
U Cin L Rev, Vol 36, No 1, pp 121-142, winter 1967, 22 p, 137 ref.

Descriptors: *Tidal waters, *Highwater mark, Low water mark, Water level fluctuations, Marshes, *Riparian rights, *Legislation, Navigable waters, Administrative agencies.

The rule in all states except Virginia and Massachusetts, is that the sovereign has the title to land below the high tide mark. The State is thought to hold the land in public trust. There are many difficulties involved in applying this rule. Problems with defining the high tide mark and also with determining it in fact have troubled the courts for years. Another source of confusion is the inconsistently applied doctrine which requires the water bordering a riparian owner's land be navigable before the high tide rule applies. Riparian owners are recognized to possess some rights in the land below high tide, though the title is in the state. These rights are not uniformly recognized, and the extent of recognition varies with the different jurisdictions. The sometimes recognized rights are: (1) Right of access to water; (2) Right to improvements; (3) Right to fill in the land. The uncertainty of titles, with the resulting unsatisfactory use of the lands, militates for the enactments of comprehensive state statutes. It is recommended that each tidewater state create an administrative agency that would have authority to determine what riparian lands are flowed by tidal waters and whether the state has retained ownership, and to convey such lands by rule from the state to a private owner.
W68-00639

FLOOD PLAIN ZONING FOR FLOOD LOSS CONTROL.
Iowa Univ, Iowa City.

Iowa L Rev, Vol 50, pp 552-581, 1965. 30 p, 2 fig, 126 ref, disc.

Descriptors: *Flood control, *Flood plains, *Flood plain zoning, Flood damage, *Comparative benefits, Public benefits, Public health, Federal

government, Engineering structures, Legislation, Local governments, State governments, Project planning, Economic efficiency, Project purposes, Federal-state water rights conflicts, Political aspects.
Identifier: Constitutional aspects.

This note examines the feasibility of controlling flood loss through the device of flood plain zoning. The annual increase in flood damage is attributed to the increasing value of the flood plain area i.e., putting more valuable uses on the flood plain insures that more valuable uses will be flooded. Flood plain zoning involves the division of the flood plain area into districts for use in accordance with anticipated flood conditions. Flood plain zoning offers an indirect supplement to federal engineering projects which have not proved sufficient to reduce flood losses. Zoning is a valid exercise of the state police power in pursuance of its authority to further the general welfare. Generally the responsibility for adoption and enforcement of zoning regulations are delegated to local government units. Constitutionally zoning acts must meet the due process test of reasonableness in purpose and application. Valid purposes are the prevention of injury to others, prevention of self-imposed injury, and the reduction of public expenditures. Federal-state cooperation has largely eliminated conflicts between federal engineering works and state flood zoning. The note concludes with a discussion on drafting zoning ordinances and a proposed flood plain zoning ordinance.
W68-00642

6G. Ecologic Impact of Water Development

ECOLOGICAL IMPACTS ON WATER RESOURCES DEVELOPMENT,
Department of the Interior, Washington, DC.
Stanley A. Cain.
Water Resources Bull, Vol 4, No 1, pp 57-74, Mar 1968. 18 p.

Descriptors: *Balance of nature, *Ecological distribution, *Water management (Applied), Ecosystems, Biogeography, Lakes, Ponds, Marshes, Bogs, Swamps, Wetlands, Estuaries, Weather modification, River systems, Tidal effects, Turbidity, Evapotranspiration, Biota, *Aquatic life, Standing waters.
Identifiers: *Ecological impact, Moving water, Case histories.

A condensed review is given of the principle conditions and processes that, by their interactions, create in nature certain arrangements called ecosystems. Development of water resources affects certain objects and conditions in nature. It is little recognized that changes in one facet of an ecosystem have ramifications and permutations that may extend throughout the entire ecosystem. The point is made that water as a resource cannot be managed fully without consideration of the consequence of single-purpose developments. Some actual water development cases and their ecological impacts are described. These include structures for flood control, irrigation, navigation, industrial and municipal water supply, hydroelectric projects and water conservation. Wetland and estuarine environments and weather modification, all subjected to intensive human use and abuse, are described in the light of values gained and values lost. It is concluded that society must have an opportunity to assess and decide on alternatives for developments that change the environment.
W68-00344

BERNHARD V CASO (EFFECTS OF DREDGING AND LANDFILL ON AQUATIC AND MARINE LIFE).

19 NY 2d 192, 225 NE 2d 521 (1967).

Descriptors: *Dredging, *New York, *Conservation, Permits, Aquatic life, Submerged lands, Marine animals, Administrative decisions, Administrative agencies, Judicial decisions, *Landfills, Beds under water, Legislation.

Petitioners owned land below the high water mark in the town of Hempstead, which they desired to fill and elevate with sand dredged from an adjoining area. Petitioners applied to the Town Board for a dredging permit. The Board told petitioners to make certain engineering studies before submitting the application. The Hempstead Permit Law stated that issuance of a dredging permit was descretionary with the Town Board, and that a permit should not be issued where the public interest would thereby be prejudiced. Petitioners did the necessary engineering work, but the Board refused to issue the permit, citing a letter from the conservation board which stated that this dredging would be harmful to marine life in the area. Petitioner appealed the Board's decision to the courts. This court held that issuance of such permits was descretionary with the Board and that destruction of marine life would prejudice the public interest; hence the Board acted reasonably in denying the permit. The dissent argued that there had been unreasonable discrimination against petitioners and that petitioners were equitably entitled to the permit.
W68-00426

CONSERVATION AND WATER MANAGEMENT,
Lyndon B. Johnson, President.
Cong Record, Vol 114, No 39, pp H1808, Mar 1968. 7 p.

Descriptors: *Water conservation, *Water pollution, Pesticide residues, River regulation, Farm wastes, Industrial wastes, Municipal wastes, Pollutants, Public health, Solid wastes, Strip mine wastes, Standards, *Pollution abatement, Sewage disposal, *Water quality control, Federal government, Legislation, Longterm planning, Government supports.

President Johnson on March 8, 1968, sent a message to Congress in which he outlined the steps he believes are necessary to preserve the natural heritage of the American people. A priority conservation agenda is proposed and the following action is recommended in the area of water pollution control: (1) water quality standards must be set for entire bodies of water; (2) standards must be enforceable and they must apply to both municipalities and industries; and (3) waste treatment plants must be constructed and new methods developed to prevent pollutants from reaching the water. In the area of water management and planning, a commission must be established to develop long-range policy for water resources. The commission would work with Federal, State and private agencies in a survey of our long-term water needs, explore the effect of water development projects on regional growth, and identify alternative policies and programs to meet national and regional water resource objectives. The message also covers other subjects such as air pollution, surface mining, solid waste disposal, agricultural wastes and the oceans.
W68-00458

07. RESOURCES DATA

7A. Network Design

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN,
Michigan State University, Institute of Water Research.
Marvin E. Stephenson.
Annual Progress Report on Project to Office of Water Resources Research, August 1968. 2 p.

Descriptors: *Watershed management, Michigan, *Information retrieval, Model studies.

This study concerns the development of suitable models which quantitatively describe the physical, chemical, biological and economic aspects of water resources management within the Grand River system, a major watershed of Lake Michigan. Initially, the project is being restricted to analysis involving the principal stream network. As work progresses a logical expansion to include lake-reservoir and sub-surface components will be made. Current activities are centering about the development of an information processing system, suitable for the projected demands of the study. This will serve as a single, accessible repository of both quantitative and qualitative data relating to water resources with the Grand River system.
W68-00496

7B. Data Acquisition

A TRANSDUCER FOR OPEN CHANNEL FLOW,
Aberdeen Univ., Marischal College, Great Britain.
J. M. Townson.
J of Hydraul Res, Vol 6, No 1, pp 45-68, 1968. 24 p, 2 plate, 5 ref.

Descriptors: *Instrumentation, *Open channel flow, Velocity, *Automatic control, Currents (Water), Estuaries, Bays, Tides, *Model studies, Rivers, Water level fluctuations, Computers, Testing, Strain gages, Calibrations, Stability, Equipment.
Identifiers: *Transducer, Vertical cylinder, *Scale models, Drag coefficient, Current direction, Bed levels, Great Britain.

The theory on which an instrument has been designed to enable simultaneous values of water level, current velocity, and current direction to be measured remotely, is explained. Practical details of the apparatus and its calibration are described, and questions of reliability and sensitivity are discussed. Experiments with open channels, especially scale models of rivers and estuaries, are adaptable to use of this instrument. An application to on-line control of a tidal model by coupling the instrument to an analog or digital computer, is suggested. Full-scale applications are also indicated. In its present form the instrument is capable of measuring speeds within the range of 5 to 25 cm/s with an accuracy of plus or minus 10%; it can measure directions with accuracy of plus or minus 5 deg and water surface levels, accuracy of plus or minus 1 mm. It is applicable to operation at surface or bed level in rivers, harbors, and estuaries, and can be adjusted to respond to high- or low-frequency variables.
W68-00317

A PREVIEW ON THE DETERMINATION OF MASS RETURN FLOW OF AIR AND WATER VAPOR INTO THE STRATOSPHERE USING TRITIUM AS A TRACER,
International Meteorological Institute, Stockholm, Sweden.
R. Michael Smith.
Tellus, Vol 20, No 1, pp 76-81, 1968. 6 p, 1 fig, 20 p.

Descriptors: *Air circulation, *Tritium, *Water vapor, Atmospheric, Fallout, *Tracers, Aerosols, Meteorology, Weather patterns, Moisture, Meteoric water, Radioisotopes, Climatology, Water balance.
Identifiers: *Atmospheric motion, *Stratosphere, Tropopause, *Jet stream, Moisture flux, Baroclinic zones, North America.

A preview is presented of work on uses of tritium in tracing atmospheric motions. Analytical results are given for moisture flux data collected over North America in July 1962; they show that it is possible to determine regions of major outflow of air and water vapor through the tropopause into the stratosphere. These regions are closely related to the mean position of the jet stream. Total masses of air and water vapor leaving the troposphere are computed. It is postulated that energy involved in the outflow of air in the vicinity of the mid latitude jet

stream and originating from large scale transient eddies is transferred directly into the lower stratosphere. This transfer of kinetic energy through the tropopause is considered to be the principal mechanism for maintenance of dynamic circulation in the lower stratosphere. Complete revision of present methods used to compute the water balance of a region seems necessary on the basis of water vapor estimates arrived at in this study. It is also concluded that tritium is an invaluable tool in meteorology.
W68-00323

MONITORING OF CHANGES IN QUALITY OF GROUND WATER,
US Geological Survey, Raleigh, NC.
H. E. Le Grand.
Ground Water, Vol 6, No 3, pp 14-18, May-June 1968. 5 p, 2 fig, 6 ref.

Descriptors: *Groundwater, *Dissolved solids, Wastes, *Groundwater movement, Groundwater recharge, Pumping, *Monitoring, Legislation, Tracers, Dye releases, Path of pollutants, Tagging, Pollutant identification, Water quality, Model studies.
Identifiers: Consolidated rocks, *Permeable media, Health practices, *Zone of contaminants, *Monitoring technology, Radioactive tracers.

Because economic methods of predicting precisely the boundary zones between contaminated and uncontaminated water are not available, monitoring wells are widely used. Water of inferior quality may occur naturally or it may be in enclaves of waste contamination lying in fresh-water bodies. Its movement toward wells may be induced by the natural hydraulic gradient or by artificial gradients produced by pumping. A prerequisite to monitoring is a conceptual model of the hydrologic system involved. Unplanned monitoring is expensive, inefficient, and fallible; planning can minimize the amount needed and optimize the results. Methods of acquiring data from monitoring wells include the use of tracers and the direct determination of contamination in samples. Because contaminants do not travel at the same rate, tracers must be selected to arrive with the contaminant to be detected. The arrival of one contaminant may or not be a precursor of another; for instance, the chlorides of sewage commonly have a greater range of dispersion than the organic materials. These factors must be included in the conceptual model necessary for proper planning of a monitoring system.
W68-00337

FLOW CALIBRATION BY DYE-DILUTION MEASUREMENT,
US Geological Survey, Washington, DC.
F. A. Kilpatrick.
Civil Eng--ASCE, Vol 38, No 2, pp 74-76, Feb 1968. 3 p, 7 fig.

Descriptors: *Calibrations, Instrumentation, *Flow measurement, *Testing, Streams, Hydraulics, Flow rates, Tracers, Dye releases, Fluoresence, Adsorption, Flumes, Analytical techniques, Laboratory tests.
Identifiers: *In-place testing, Measuring instruments, Fluid flow, Rating, *Dye-dilution measurement, Water soluble tracer.

Successful measurement by the U.S. Geological Survey of flow in natural streams and waterways by dye-dilution methods is described; the feasibility of using the technique for in-place rating of certain meters and structures is suggested. Tests and results are presented for orifice, bend, venturi meters, weirs, and flumes. Dilution gaging involves the introduction of a known amount of soluble tracer and the accurate measurement of degree of dilution at some place downstream where a homogeneous mixture has resulted. Fluorescent dyes have high detectability, and are low in cost and easy to obtain and handle; also, adsorption losses usually are small. Various equipment for injecting the dye and taking samples is available for both laboratory and in-place testing of instruments and structures.
W68-00351

SAMPLING EQUIPMENT FOR GROUND-WATER INVESTIGATIONS,
Federal Water Pollution Control Administration, Ada, Okla.
Leslie G. McMillion, and Jack W. Keeley.
Ground Water, Vol 6, No 2, pp 9-11, Mar-Apr 1968. 3 p, 2 fig.

Descriptors: *Sampling, Hydrologic data, Instrumentation, Water analysis, Measurement, *Pumping, *Pumps, *Wells, Water wells.
Identifiers: Submersible pump, FWPCA, *Sampling pump, Water well sampling.

Portable pumping equipment for well sampling has been constructed by the Robert S. Kerr Water Research Center. The equipment is described in the written text, photographs, and detailed drawings. Sampling can be done at depths to 300 ft at rates between 7 and 14 gpm depending on depth. The unit is mounted in a small panel truck and is easy to operate because only 1 line, a wire-reinforced 1-in. rubber hose that supports a submersible pump and contains the power line, is used. The well to be sampled must have an inside diameter of at least 4.5 in. The pump may be raised or lowered 20 ft per min.
W68-00512

A DEVICE FOR DETERMINING SEDIMENTATION RATES IN RESERVOIRS,
Bureau of Sport Fisheries and Wildlife, North Central Reservoir Investigations, Yankton, S Dak.
Bruce C. Cowell, and P. L. Hudson.
Limnol and Oceanogr, Vol 13, No 1, pp 196-198, Jan 1968. 3 p, 2 fig.

Descriptors: *Sedimentation rates, *Instrumentation, Deposition (Sediments), *Reservoirs, Core drilling, Distribution patterns, Bottom sediments, Scuba diving.
Identifiers: Closed container, *Sediment samples, Apparatus.

A brief technical note is presented on an apparatus that allows more rapid determination of sedimentation rates than core sampling. It can be stabilized at a desired depth above the bottom so that flocculent bottom materials are not collected. Since it can be closed before it is retrieved, it is not subject to some errors associated with open containers. Data obtained from it are more representative of the gross sedimentation rate than the net rate. Therefore, this apparatus is used only to provide comparative data between stations within a reservoir or between reservoirs in the same river system. A diagram and a photograph accompany the technical description.
W68-00513

BED-LOAD SAMPLER DEVELOPED FOR SEDIMENT STUDIES,
U.S. Lake Survey, Technical Publications Office.
C. Z. Cashman.
Ocean Ind, Vol 3, No 7, pp 84,86,88, July 1968. 3 p, 1 photo, 1 tab.

Descriptors: *Bed load, Great Lakes, *Sampling, Dredging, Currents (Water), Sediment transport, Marine geology, *Silting, Silts, Research and development, *Instrumentation, Mechanical equipment.
Identifiers: *Arnhem bed load sampler, *Great Lakes Research Center.

A bed-load sampler of Dutch design was constructed with permission of the designer, the Directorate, Upper Rivers of the Netherlands, for the Great Lakes Research Center. It is operated with a cable and winch from any suitable boat. The fin assembly is designed so that the sampler's orientation is always parallel to direction of flow. As the sampler is raised or lowered, cable tension puts the collector mouth in the non-sampling position. Release of cable tension lowers the mouth to the bottom, on which it exerts a constant force regulated by a spring. A nearly flat bottom is necessary for proper operation. High current velocities caused placement problems and sometimes kept enough tension on the cable to interfere with mouth position; but generally the sampler was satisfactory.
W68-00570

08. ENGINEERING WORKS

8A. Structures

BEAVER BROOK DAM AND RESERVOIR, KEENE, NEW HAMPSHIRE.
Corps of Engineers US Army.

US 90th Cong, 2d Sess, Senate Doc No 68, 99 p, Feb 1968. 2 plate, 6 photo, 6 tab, 6 append.

Descriptors: *Flooding, *Flood control, *Dams, *Flood damage, Fishing, Boating, *Recreation, Water supply, *Multiple-purpose projects, New Hampshire, Cost-benefit ratio, Streams, Streamflow.
Identifiers: Keene, Connecticut River basin, Ashuelot River basin, Beaver Brook.

A dam is proposed to control flooding, a serious problem in the city of Keene. The damage from Beaver Brook flooding was $218,000 in 1938, $100,000 in 1960, with smaller but substantial amounts in many other recent floods. All other practicable methods for solving the problem, including channel improvements, diversion, modification of dams already in existence on the Ashuelot river (to which Beaver Brook is tributary) flood plain zoning, and evacuation of population, were considered, but rejected because of high cost. The most economic plan was a multiple-purpose storage reservoir on Beaver Brook. The estimated first cost is $1,377,000 with annual charges of $57,700. Average annual flood prevention, water supply, and recreation benefits are $165,700. Increased future water needs may be met by conversion to a water-supply reservoir when needed. This will increase Keene's present supply of 3.5 mgd to 6 mgd.
W68-00315

8B. Hydraulics

WAVE PROPAGATION AND BOUNDARY INSTABILITY IN ERODIBLE-BED CHANNELS,
Massachusetts Institute of Technology, Cambridge, Mass.
M. H. Gradowczyk.
J of Fluid Mech, Vol 33, Pt 1, pp 93-112, July 12, 1968. 4 fig, 1 tab, 27 ref.

Descriptors: *Fluid mechanics, Hydrodynamics, *Sediment transport, Flumes, Movement, Running waters, Sand waves, Dunes, Open channel flow, Depth, Beds, Regime, Roughness (Hydraulic), Scour, Critical flow, Waves (Water), Supercritical flow, Dimensional analysis, Froude number.
Identifiers: Shallow flow, Gravity waves, Linear stability analysis, Wave propagation, Boundary instability.

Wave propagation in linear erodible-bed channels is discussed by using the shallow-water approximation for the fluid and a continuity equation for the bed. In addition to gravity waves, a third wave which gives the velocity of propagation of a bed disturbance is found. Dimensional analysis yields the quasi-steady approximation for the complete shallow-water equations. Linear stability analysis of free-surface flows is extended to include erodibility of the bed. The critical Froude number above which the free surface may become unstable is obtained. Erodibility increases free-surface stability in agreement with previous experiments. The stability theory is also used to discuss coupled bed and surface waves. From it 5 configurations are obtained:

a sinusoidal wave moving downstream, a transition zone, antidunes moving upstream and downstream, and a stationary antidune. This is in agreement with experimental results; thus, shallow-water theory seems to explain boundary instability reasonably. The quasi-steady approximation and Kennedy's stability analysis will be in agreement within stated limits; when the phase shift is introduced into the approximate equations, the 5 patterns derived from the full equations are found.
W68-00520

NONLINEAR FLOW THROUGH GRANULAR MEDIA,
Inperial College of Science and Technology, Department of Civil Engineering, London, England.
David Ellis Wright.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6018, pp 851-872, July 1968. 22 p, 9 fig, 1 tab, 23 ref, 3 append.

Descriptors: Unsteady flow, Flow, *Gravels, Darcys law, Turbulence, Reynolds number, *Hydraulics, Testing, Velocity, Porosity, Laminar flow.
Identifiers: Air flow, Steady flow, *Nonlinear flow, *Granular media, Sands, Velocity wave.

Roles of steady and unsteady flows in causing deviation from the linear Darcy resistance law are described in connection with the experimental objective of detecting and measuring turbulence and observing the effect of convergence of macrostreamlines on the behavior of the Reynolds number-resistance coefficient relation. Air velocities and turbulence intensities were measured within the pores of a gravel bed by hot-wire anemometers. Results indicate that although the linear resistance relation ceases to be valid at a Reynolds number of about 2, velocity fluctuations do not begin until the Reynolds number is about 100, and turbulence is not fully established until it is at least 800. Studies of water flow through a coarse sand bed showed that convergence of the macrostreamlines significantly reduced the resistance at Reynolds numbers over 10, the proportionate reduction increasing with flow. The observations are interpreted in terms of flow through coiled pipes or round immersed objects, and 4 regimes of flow through granular media are proposed.
W68-00533

STRUCTURAL DAMAGE FROM TSUNAMI AT HILO, HAWAII,
University of Texas, Department of Civil Engineering, Austin, Texas.
Lymon C.Reese, and Hudson Matlock.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6037, pp 961-982, July 1968. 22 p, 20 fig, 1 tab, 15 ref, 1 append.

Descriptors: *Tsunamis, *Waves (Water), Surges, Flooding, *Hawaii, *Structural analysis, Earthquakes, Earth-water interfaces, Velocity, Head loss, Bores, Bays, Monitoring, Ocean waves, Damages, Shores, Hydrodynamics, Structural design.
Identifiers: *Seismic sea waves, Wave characteristic, Water elevation, Case studies, Hilo, *Structural damage.

Structural damage caused by a series of destructive seismic sea waves which struck Hilo, Hawaii in late May 1960 is described analytically. Triggered by a catastrophic Chilean earthquake, the waves crossed the Pacific and reached Hawaii as a large tsunami. A team of scientists and engineers surveyed the extensive structural damage and studied the tsunami wave characteristics. A 580-acre was inundated in Hilo with a loss of $20,000,000; 308 business and public buildings and 229 dwellings were destroyed or severly damaged. Presented are results of the findings from onshore effects of wave height, structural damage caused by the wave, and pressure on structures from wave force. Wave velocity was estimated by 3 methods with reasonable agreement among the methods. Various conditions which affected the degree of damage are described. Analyses of several structural elements are given and conclusions and recommendations formulated.
W68-00534

MEANDERING TENDENCIES IN STRAIGHT ALLUVIAL CHANNELS,
Colorado State University, Fort Collins, Colo, and Gifu University, Gifu, Japan.
Hsieh W. Shen, and Saburo Komura.
ASCE Proc, J of Hydraul Div, Vol 94, No HY4, Pap 6042, pp 997-1016, July 1968. 20 p, 11 fig, 5 tab, 11 ref.

Descriptors: *Hydraulics, *Meanders, Scour, Sedimentation, *Alluvial channels, Sediment transport, Stream erosion, Streamflow, *Channel morphology, Laboratory tests, Flumes, Aggradation, Nonuniform flow, Velocity, Data collections, Vortices.
Identifiers: *Secondary currents, Streambed pattern, Helicoidal motion, Flow depth, Problem analysis, Wall roughness.

The primary purpose of the investigation described is to expand an earlier study by Einstein and Shen in which 2 types of meandering patterns were observed in straight alluvial channels. Meandering bed pattern with alternate scour holes, which occur in alluvial river channels, was reproduced consistently in a straight laboratory flume. The occurrence of this pattern was directly related to: (1) the presence of rough walls, and (2) the increase of main flow velocity with both time and distance. This study demonstrates the importance of investigations on velocity and nonuniform flows for understanding river morphology. Construction of dykes in a wide river to restrict width for navigation depth may expedite river meandering. Data-collection programs for background information can aid river developers in such problem solving.
W68-00540

8D. Soil Mechanics

1967 REP ATT'Y GEN FLA 067-91 (STATE LEGISLATIVE RESTRICTIONS ON DREDGING, BULKHEADING, AND FILLING),
Attorney General, State of Florida.
Earl Faircloth.
Rep Att'y Gen Fla 067-91, Dec 28, 1967. 5 p.

Descriptors: *Legislation, Statutes, *State government, Legal aspects, State jurisdiction, Submerged lands, *Administrative agencies, Bulkhead lines, *Florida.
Identifiers: *Attorney General Reports.

The Director of Trustees of the Internal Improvement Fund requested an opinion on the question of whether the Randell Act, Fla Laws 1967, ch 67-393, made certain restrictions on bulkheading, dredging and filling contained in the Bulkhead Act, Fla Laws, ch 57-362, applicable to Monroe County. The Bulkhead Act exempted Monroe County from certain limitation as to dredging, bulkheading and filling contained in the body of the act. The Randell Act amended the Bulkhead Act to apply to 'the state, its agencies, and all political subdivisions and governmental units.' The opinion concludes that the Randell Act does remove the exemption enjoyed by Monroe County under the Bulkhead Act. Thus Monroe County is now subject to the limitations on dredging, bulkheading, and filling contained in the Bulkhead Act.
W68-00615

10. SCIENTIFIC AND TECHNICAL INFORMATION

10A. Acquisition AND Processing

SOCIAL SCIENCE STUDIES OF WATER RESOURCES PROBLEMS: REVIEW OF LITERATURE AND ANNOTATED BIBLIOGRAPHY,
Social Science Research Ctr., Miss. State Univ., State College, Miss.
R. N. Singh, and K. W. Wilkinson.
Completion Report to the Office of Water Resources Research, Department of the Interior, July, 1968, 82 p.

Descriptors: Social science, Organization, Community, Attitudes.

A review of 187 items of literature concerned with human behavioral aspects of water resources problems revealed major trends in the development of a systematic body of theory and findings in this area. Using an interdisciplinary or field-theory appraoch to conceptualization of the focal problems, works dealing with organizational variables, community structure and individual participation and attitudes were systematically analyzed for content and structure. Items for the review were taken from behavioral science journals, bulletins, books, clearing house reports, research catalogs, and project statements and papers. These were abstracted and material classified using systematic procedures of content analysis, and an annotated bibliography for use by scientists and practitioners was constructed. Findings were as follows: (1) despite increased activity in recent years, systematic social science research concerning water has been limited in scope and quality, (2) major social science problems in the water resources field, notably problems of organizational interrelationships, community and agency interactions, and individual motivation have been delineated and are being pursued, (3) there is substantial basis for convergence of sociological and applied interest in water resources. Guidelines for future research parallel statements of past deficiencies in the field.
W68-00506

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